Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

MARCH, 1911.

X-RAYS.

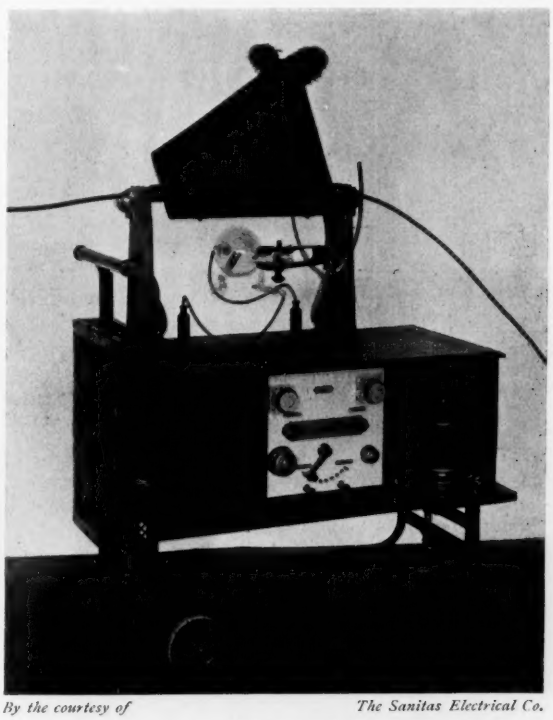
By REGINALD MORTON, M.D.

(*Continued from Volume XXXIII, page 499.*)

IN the course of an article in a previous number, the development of some of the various parts that go to make up a modern X-ray equipment was briefly described; of those that remain to be dealt with, none have a greater importance than the interrupter, or "break" as it is generally called. As its name indicates, its function is to interrupt or break the flow of current through the primary coil of the inductorium. A sudden interruption is essential for the working of the coil, and the more sudden and complete it is the better is the discharge from the coil. Up to the time of Roentgen's discovery breaks were of a simple and not very efficient form; they were only used in circuit with batteries of low voltage, and as the induction coils were as a rule small in size and giving short spark length they answered well enough.

The demand for greater discharges to excite heavier and stronger tubes soon made it evident that the interrupter would have to be modified, especially as it was desired to make use of the comparatively high pressure currents from the street mains. The platinum hammer break (see Figure 2) was one of the first, and though it is seldom used now for heavy work, and mostly on portable apparatus, in its most modern form it can be made to give very good results. It requires care in adjustment and manipulation, but is practically the only kind that can be used in military service in the field.

A disadvantage of this form is the flashing that takes place between the platinum points every time the current is broken; this is troublesome when it is desired to make use of the fluorescent screen in a dark room.



By the courtesy of *The Sanitas Electrical Co.*

FIGURE 1. An X-Ray Cable-Testing Outfit.

It was found that when the break was so modified that one of the points was replaced by a dish of mercury, the spark from the coil was intensified. In one of the earliest types a copper wire was made to dip in and out of the mercury by the action of a small electric motor, and a number of these are in use, for X-ray treatment especially. (See Figure 4.)

Following on this we have the mercury jet breaks, which were a great improvement, in that they gave a much higher rate of interruption for the same quality of discharge from the coil. In these a small jet of mercury is made to impinge upon a copper

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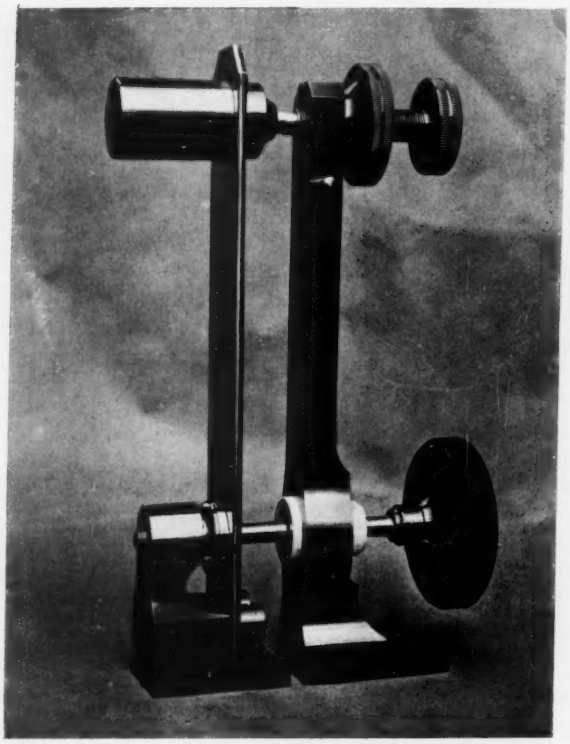
blade or blades. It is immaterial whether the jet revolves or whether the copper teeth revolve around the jet, the result is the same. The mechanism is enclosed in a glass or iron vessel, which contains a quantity of mercury at the bottom, and then filled up with spirit or paraffin oil. The break thus taking place under the surface of the fluid is all the more sudden and complete, and this type of mercury break has been, and is, very popular. The great disadvantage is the large quantity of mercury required (twenty to thirty pounds in some) and the rapidity with which the latter becomes emulsified and useless for the time being. Most of the mercury can be recovered, but the process is very messy. (See Figure 3.)

Owing to this difficulty of cleaning, efforts were made to find some gaseous medium to replace the liquid in common use, and it was found that ordinary house gas was all that could be desired; and it may be said that any mercury break designed for the use of liquid will work equally well, or even better, if the gas is used instead. The case has, of course, to be made tightly-fitting so as not to allow free escape of the gas. Used in this way the mercury does not become emulsified, only a small quantity is required, and the small amount of black mercury compound that gradually forms need only be removed at long intervals.



By the courtesy of *Messrs. Newton & Co.*

FIGURE 2. A Platinum Break.

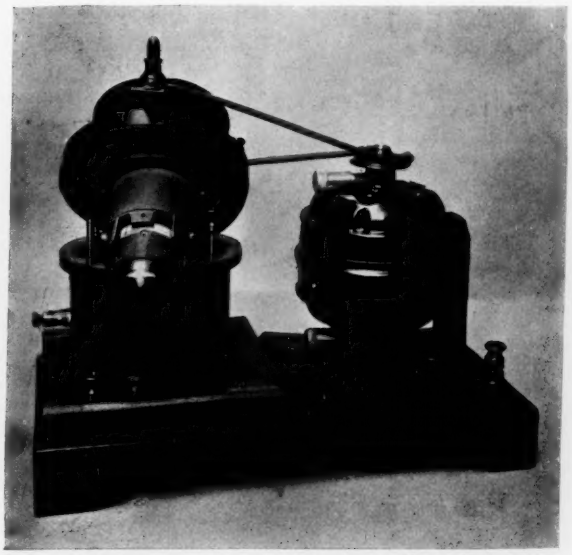
The most recent development of the mercury break is a more or less radical departure from the jet type we have been considering, but the change is a very important one, and the system upon which they work is one that is likely to prevail. The principle involved is an old one, though its application to interrupters is quite new. It is well known that if we fill a hollow sphere with liquids of different densities, and then rotate the sphere rapidly, the various liquids will tend to arrange themselves around the equator of the sphere with the heaviest liquid against the wall and the lightest liquid nearest the centre of rotation. Applying this principle to an interrupter, the hollow sphere is flattened at the poles and the equator is bulged out. This form is found to give the best results, as might be supposed. (See Figure 5.) Into this jar is placed some mercury and paraffin oil, and the whole is mounted upon the end of the shaft of an electric motor, which is placed vertically. As the latter is set in motion the jar turns with it, and the mercury, by virtue of its greater weight, at once takes up its position at the widest part. Its rate of rotation is a little less than that of the jar, which is made of cast iron, both for its strength and its resistance to the action of mercury. There are several forms of interrupter working on this principle, but the above arrangement forms the basis of them all. In one of them, a fibre disc with a metal segment, and about the size of a five-shilling piece, is mounted so that its edge engages the whirling band of mercury. This causes the disc to rotate rapidly, and as the metal segment touches the mercury the circuit is completed, to be suddenly and completely broken when it leaves.

The "make" and "break" in other modifications of this type need not be described in detail; they are by far the most efficient of the mercury breaks, and the mercury is not emulsified and used up anything like so rapidly. Electrolytic breaks are not so much used now as they were some time ago. These work on an entirely different principle and are the simplest in construction of all of them. They require a great deal of current, and the effect on the X-ray tubes is rather severe, but many radiologists prefer them to any other form. Their action is fully explained in most text books on electricity, but is too technical for an article of this kind.

When we consider the remarkable property of the X-rays in readily passing through substances that are quite opaque to ordinary light it would seem that such ought to be of the greatest use under many and diverse conditions. In the early days of their discovery many extravagant predictions were made as to their probable value and these were treated more or less seriously. As a matter of fact, if we take away their application in medical and surgical work, so little remains that the demand for the necessary apparatus would be so small as to be unworthy of the serious attention of any manufacturer, except in the fulfilment of a special order.

It will be thus easily understood how difficult it is, when treating of the uses of the X-rays, to avoid reference to medical matters. Their limited use in other directions is due to several causes, and the chief one is that the X-ray image is a silhouette and not a

photograph, as it is sometimes erroneously termed. The property of arresting the passage of the X-rays



By the courtesy of *Messrs. Newton & Co.*

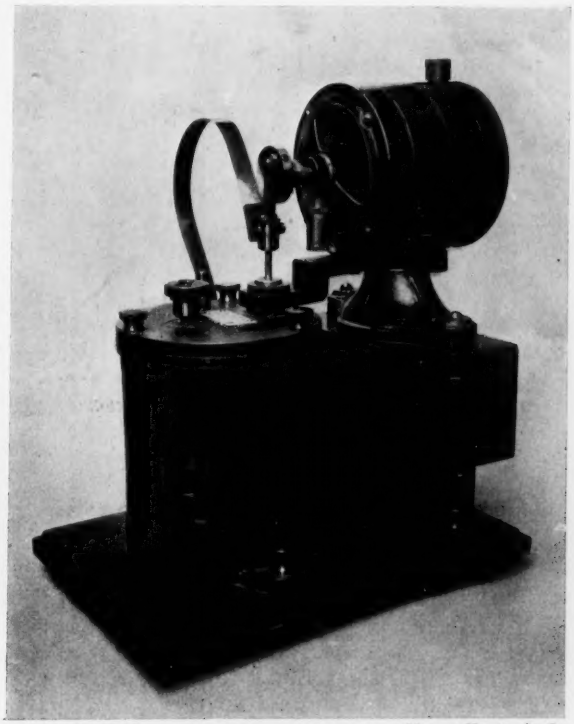
FIGURE 3. A Jet Break.

and thus casting a shadow is purely a question of the atomic weight of the elements that make up any substance. Speaking generally, substances of vegetable and animal origin, except the bones, are very transparent. With the exception of aluminium, all the metals in common use are more or less uniformly opaque. Calcium having an intermediate atomic weight is semi-transparent, and as lime salts enter very largely into the structure of most living organisms, the X-rays are very valuable in studying their normal structure as well as tracing departures from the normal, whether from disease or accident. Any inequalities in thickness are registered on the screen or plate, and so accurately is this done under favourable conditions that the details of structure can often be made out; a good radiograph of the hand or foot shows this very well.

Some very interesting discoveries have been made in this way regarding the internal structure of shells, and the Rays have been used in examining oysters for the presence of pearls. If no pearls are present the oyster is returned to the sea, which is presumably an advantage to the oyster. In a like manner electrical cables are examined (see Figure 1), both for the continuity of the conductor as well as to see that it maintains its proper relation to the other members of the system. The modern electric cable is in many instances a very highly specialised structure, that has to stand very severe strains both mechanical and electrical, and, as an apparently small fault may give rise to very serious trouble, the final inspection has to be carried out with the greatest care before it is passed as fit for service.

With regard to the medical and surgical uses of the X-rays, most people are inclined to think that the examination of fractures and the detection of foreign bodies within the human organism constitute the main field of their usefulness. These are, of course, very important applications, and ones that count for much in hospital practice particularly, but they do not by any means constitute the whole. An ordinary simple fracture occurring in the shaft of a long bone such as in the middle of the upper arm, can be dealt with quite satisfactorily, whether examined by the X-rays or not; but the surgeon who attempts to deal with a fracture close to, or involving a joint, without having it properly examined by this method, takes a risk to his patient, as well as to his own reputation, that is not justifiable. An instance of this is shown in the accompanying radiograph (see Figure 6); this injured wrist was declared to be a severe sprain and treated as such. Fortunately the patient decided to come to the hospital, where it was X-rayed as a matter of routine. This shows that the bone is not only broken in at least three fragments, but that one of the lines of fracture enters the wrist joint. The fact that there was no displacement of the fragments led to the erroneous diagnosis being made, and had this been treated in the ordinary way a stiff wrist joint would have resulted almost certainly.

In the early days of the X-rays their use was almost entirely confined to strictly surgical cases; nowadays the method is used almost as much for the investigation of medical cases, such as disease of the respiratory organs, the heart and great blood vessels,

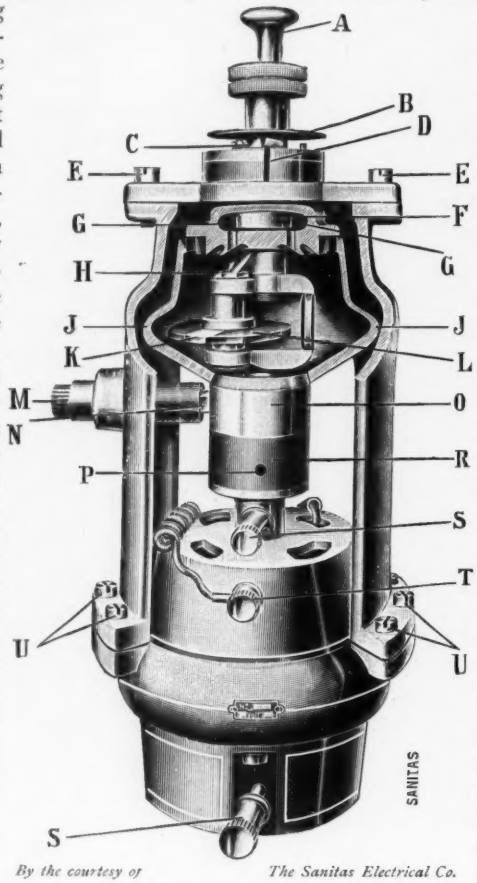


By the courtesy of *Messrs. Newton & Co.*

FIGURE 4. A Dipper Break.

tumours, and obstructions in the digestive system. The latter is a comparatively recent development, and is one that is of great interest. The method consists of giving jelly or other food containing a large amount of a bismuth compound that is quite harmless. The bismuth being opaque to the X-rays the progress of the food can be watched in its progress along the digestive canal, and at times the information gained is very valuable. There is a great danger, however, in misinterpreting the appearances, because similar shadows may be made by very different conditions; in no instance is the opinion of an expert more necessary than in this.

By means of very powerful apparatus more or less instantaneous radiographs can be made of the heart when the X-ray tube is placed no less than two metres from the plate, as shown in the illustration accompanying the first part of this article. Owing to the great distance of the tube, the size of the shadow of the heart is very nearly the same as that of the heart itself, and it is the best method at our disposal for accurately determining the dimensions of that organ. Changes in these dimensions can be detected by making examinations at intervals. This by no means exhausts the list of applications of the X-rays in the diagnosis of disorders of mankind, but enough has been said to show how much progress has been made, and the science is by no means at a standstill. Improvements in methods and in personal skill are being introduced every day, and scarcely a month passes that does not give us something new in the way of improved appliances.



By the courtesy of *The Sanitas Electrical Co.*

FIGURE 5. A Sanax Break in Section.

It was comparatively soon after the discovery of the X-rays that some investigators began to employ the radiation for purposes of treatment. They were led to do this from the good results that were being obtained with the ultra-violet rays, and from the fact that many X-ray workers had begun to suffer from a form of dermatitis, which was rightly attributed to the influence of the X-rays themselves. It was at this stage that the foundations were laid for the immense amount of suffering that has been endured by many of the pioneers of X-ray work, many of whom still continue to suffer in one way or other, in spite of the fact that they have taken every possible precaution since the first attack of the dermatitis. The danger from these rays is only incurred by those who are working with them more or less continuously; there is not the slightest danger to any one who undergoes an examination or a course of treatment by the X-rays, so long as the work is done by one who is a recognised expert in such matters.

It may be taken as an axiom that any agent that is capable of doing so much harm as this can also be made to do a great deal of good, if only its powers are properly controlled and directed into the right channels. The great trouble in administering these rays therapeutically was that of knowing how large or how small a dose was being given, and even at the present time the methods at our disposal are not anything like so simple and scientific as that of giving ordinary drugs. We have no satisfactory method of ascertaining the exact strength of radiation the patient is getting at any given moment; our methods will only tell us how much has been given, and that rather crudely. The means mostly employed are sufficiently accurate in the hands of one who has had a considerable experience of the work, and who has become more or less familiar with the vagaries of the X-ray tube. The day is not yet that the novice can dip into this work without running considerable risk.

When the platino-cyanide of barium is exposed for a certain time to the influence of the X-rays it turns from its usual greenish-yellow tint to that of a light orange. This material is spread upon stiff paper and cut into small circular pastilles. The X-ray tube is enclosed in a ray-proof shield, from which the rays can escape only by an opening made for the purpose, the size and shape of which can be altered to suit any ordinary conditions. The pastille is held in a clip exactly half the distance between the source of the rays and the area to be treated, and is so arranged that it can be removed for examination from time to time. With each set of pastilles is supplied a standard tint, to which the pastille must change before the ordinary full dose is given. This is, in outline, the method in use at the present time by the majority of radiologists. It is, admittedly, a crude one when judged by other standards of measurement, but in the hands of the expert it gives very good results. The arrangement is shown on page 498 of the previous article ("KNOWLEDGE," Volume XXXIII, December, 1910).

With regard to the conditions that are benefited by this form of treatment, it may be said that the more superficial is the disorder the more likely is it to be favourably influenced; this is only another way of saying that the method finds its greatest field of usefulness in the treatment of the diseases of the skin, and the results that have been obtained are at times quite remarkable. It is a very fortunate thing that it is among those conditions that are, as a rule, very resistent to all ordinary methods of treatment, that some of the greatest successes have been made.

Of course, X-ray treatment is not confined to cutaneous disorders: their field of usefulness is a very wide one, but this is scarcely the place to enlarge upon this side of the question. It is, in fact, a pity that so much has been said upon the medical aspect of the question but, for reasons that are obvious, its avoidance is a matter of some difficulty.

FIGURE 6. A fracture of the lower end of the radius involving the wrist joint.

This injury could not have been accurately diagnosed except with the assistance of the X-rays.

Before closing this article it may be of interest to indulge in a little speculation as regards future developments. While we have seen that improvements in the electrical appliances have been going on from the very beginning, and show little sign of any falling off in this gradual but steady improvement, the X-ray tube itself has undergone no radical change since the invention of the focus tube by Professor Herbert Jackson.

It is quite true that the X-ray tube of the present day is a great improvement on the original Jackson tube; it is larger in size, more steady in action, and more capable of withstanding the various and severe stresses to which it is subjected, and is also provided with a means of regulating its vacuum; but it remains in principle as it always was, and great as its improvement has been it has not kept pace with the development of the electrical side of the X-ray equipment. Any modern coil can completely wreck any X-ray tube in a few seconds if desired. Our greatest want now is a tube that is steady in action and in vacuum, that will give out a certain quality of radiation as required, and no other, and continue to give this no matter how great power is applied to it within the limit of reasonable requirements. With a view of meeting some of the conditions it has been suggested to make the bulbs of quartz instead of glass, but so far no one seems to have attacked the problem seriously. Quartz is much more transparent to the X-rays than any form of glass, it is independent of any changes of temperature, and will stand any amount of rough usage within reasonable limits. It certainly should be well worth giving a thorough trial, if only for the advantages already mentioned. But even with these advantages it could not be said that the X-ray tube was in the nature of a perfectly satisfactory instrument. In the present state of our knowledge it is very difficult to see how the X-ray tube can be radically improved upon. We can only wait patiently; and for all we know some means of getting our X-rays may be discovered that is much more simple and reliable, and entirely different from the methods we use at present.

THE ROYAL INSTITUTION.

A GENERAL Monthly Meeting of the Members of the Royal Institution was held on the afternoon of February 6th, The Duke of Northumberland, President, in the chair. Mr. and Mrs. Alfred Carpmael, Dr. W. S. Colman, Mr. Guy Ellis, Mrs. E. B. Fielden, Dr. A. H. Levy, Mr. Basil Mott, Mr. A. F. C. Pollard, and Dr. N. Raw were elected Members. The Treasurer reported that he had received £1,200, part of the legacy to the Royal Institution of the late Miss Wolfe, and £62 10s., a portion of the legacy of the late Mr. C. E. Layton. The special thanks of the members were returned to Dr. J. Y. Buchanan for his donation of £100 to the fund for the Promotion of Experimental Research at Low Temperatures. The Institution has recently received a gift of £1,000 from Dr. Muller.

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HOW YOUNG BIRDS LEARN TO SING.

By G. W. BULMAN, M.A., B.Sc.

THE question of how a young bird learns the peculiar song of its own species is an interesting one, although the subject does not seem to have much engaged the attention of Naturalists. Walking from Hexham to Corbridge in Northumberland early last August, I had the pleasure of listening to the singing lesson of a young yellow hammer. One bird, the pupil, with slightly weaker and less decided song, was answering another which sang in a clearer and more finished style. There was no mistaking the fact that the first song came from the more accomplished songster, and it was hard to resist the conviction that the other was an imitation. It seemed, in fact, a young bird learning to sing. Several times the instructor gave the complete song—"A very, very little bit of bread and NO cheese"—and the pupil replied also with every note. There was no hurry, and always a quite perceptible pause between the songs. Then some three times in succession the teacher gave the song without the final note. And the pupil duly replied with a song one note short. Then the instructor went back to the complete version, but so long as I listened it was answered by the incomplete song.

This incident recalls some observations on the subject made some years ago. August is a specially favourable time for listening to the yellow hammer's song. Then it seems to come out with a clearness and beauty peculiar to the season. Whether this is due to the silence of the louder songsters, or whether the yellow hammer's song really improves by practice as the year advances, is perhaps uncertain. And in listening to this August songster I had often thought there must be two similar but distinct bird songs, and tried to make out to which of the buntings the other could belong. The one song was rapid, clear, and distinct, the other slow and frequently omitting the proper ending. But listening carefully one afternoon I convinced myself that the former was that of the old bird, and the latter that of the young one learning to sing. First of all came the quick, clear, decided song, and then, after a few seconds, the slow, hesitating, and often stopping short imitation. These were given in regular alternation for a long time. As I listened to them, it was impossible to resist the conviction that it was a young bird receiving its singing lesson. A somewhat similar account of a young bird learning to sing was recorded some years ago in the pages of a natural history periodical known as the *Field Club*, now no longer extant. Personally I have not met with any evidence that any other species learn their songs in this way. Nor have I come across the records of any other observers who have heard similar singing lessons, except the above-mentioned case, which, I believe, also referred to the yellow hammer. Young robins, song thrushes, and blackbirds, which I have heard making their early efforts, have always been singing alone.

Many years ago the Hon. Daines Barrington made some interesting experiments. He reared young linnets under skylarks, woodlarks and titlarks, and found that in each case they learned the song of their foster-parent instead of their own. He concluded, therefore, that the song of a bird is no more innate than language is in man. And more recently the experiment of rearing Baltimore orioles altogether apart from their parents has been tried. Two which were thus reared in a fourth floor flat in Boston, developed a song of their own, different from the proper song of the species. Other nestlings afterwards reared in the company of these two also learned the new song. Mr. Hudson, again, notes the case of the oven bird, the young of which apparently learn by imitating their parents while still in the nest. The old birds, it appears, sing a sort of duet together, and according to the above naturalist, "the young birds, when only partially fledged, are constantly heard in the nest or oven, apparently practising these duets in the intervals when the parents are absent."

The direct imitation explanation of bird-song is strengthened by the fact that in many birds the imitative faculty seems to be strong. Putting aside the familiar cases of our own starling and the American mocking bird, the following examples of imitation in birds not usually mimics may be cited. On one occasion I heard a blackbird crow like a cock. And I find that Yarrell records the fact that it is occasionally known to do so. On another occasion I heard a robin imitate the song thrush. Again, on one occasion only, I heard a skylark twist the song of a chaffinch into its own more copious melody. I incline, however, to think that this may have been unconscious imitation.

There are birds, however, like the cuckoo, which apparently cannot learn by imitation, whose song must be supposed to be innate. And the case of *Rhynchotus rufescens* cited by Mr. Hudson is of similar import. A young bird of this species was taken from the nest when just breaking the shell. It was reared where it had no chance of hearing the song of its species. Yet long before it was full grown it would retire to a dark corner of the room, and give its characteristic evening song in great perfection.

XUM

A NEW SPECTROSCOPE AND SPECTROGRAPH.

By R. A. HOUSTOUN, M.A., Ph.D., D.Sc.

(Natural Philosophy Department, University of Glasgow.)

THE type of spectroscope for general use in physical or chemical laboratories is now pretty well fixed. There is a telescope and collimator, both with achromatic glass lenses, the collimator being fixed, and the telescope moving round a divided circle. If the spectrum is to be photographed, the eyepiece end of the telescope is replaced by a box carrying a photographic plate at its end. With an instrument of this kind work can be done in the visible spectrum and in the ultra-violet to about $330\mu\mu$; if we wish to go further, quartz lenses and a quartz prism must be used. Quartz lenses and a quartz prism will also carry us considerably further into the infra-red than glass. But the quartz prism in general use, the Cornu double prism, gives a sharp image only when set at minimum deviation, and the focal length of a quartz lens varies so rapidly with the wave-length that the photographic plate must be set with its surface at an angle of about 21° to the axis of the camera. The focussing of the plate may thus be a lengthy process. On account of these complications and the cost of the special apparatus involved, the experimenter of moderate means and limited experience usually avoids the ultra-violet and infra-red.

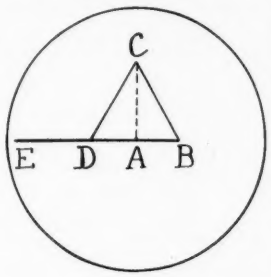

FIGURE 1.

The object of this short paper is to describe a cheap and simple form of spectroscope of radically different design, which is eminently suited for the amateur who wishes to work in these regions, and which is also suitable for the visible spectrum. It does not appear to be known in this country, although frequently used in research work in America. In this instrument the lenses are replaced by mirrors, and the Wadsworth mirror-prism combination is used. The Wadsworth mirror-prism combination consists of a prism and mirror mounted together on the prism table, with the plane of the mirror and the plane that bisects the refracting angle of the prism both meeting in the axis of rotation of the prism table. The diagram (see Figure 1) illustrates a special case of the arrangement; ED and CA are respectively the traces of the two planes referred to, and they both meet in A, the point through which the axis of rotation of the table passes.

Now consider any ray FGHJK (see Figure 2) passing through the prism at minimum deviation, and being reflected by the mirror. Its path through the prism, GH, is parallel to the base of the prism, DB, and JK is parallel to FG. From A draw AP, AN and AM perpendicular respectively to FG, HJ and JM. Then by symmetry AP=AN, and by equal triangles AM=AN. Consequently AP=AM. Suppose that the ray FP is white light; the colour in this ray that suffers minimum deviation emerges along JK after passing through the system. Rotate the prism and mirror through the same small angle, keeping the direction FP fixed. Then AP and AM are fixed, and consequently JK is fixed. A different colour now suffers minimum deviation, but emerges along the same straight line JK.

Suppose now that the single ray FP is replaced by a beam of parallel rays and that the prism table is rotated; each colour in turn, as it suffers minimum deviation, is undeviated and at the same time suffers the same constant parallel displacement.

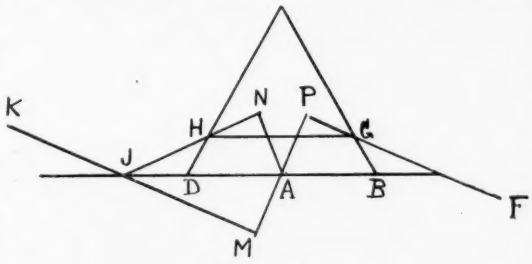

FIGURE 2.

The next diagram (see Figure 3) shows how these properties are taken advantage of. ABCD is a solidly-made box, the lid of which has been removed and into which we are looking vertically down. S is a slit attached to a piece of brass tubing which slides in a short piece of tube fixed in the side of the box. The light from the slit is rendered parallel by

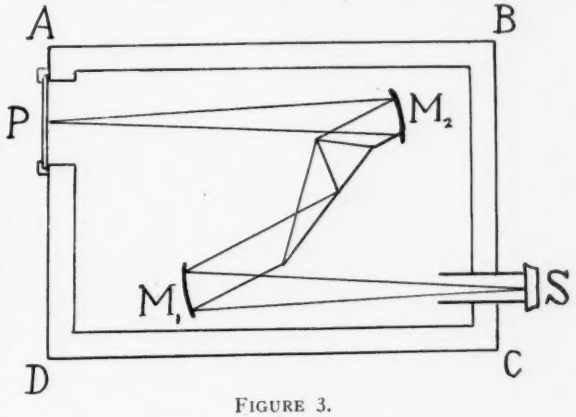

FIGURE 3.

the concave mirror M_1. It is then acted on by the mirror-prism combination, falls on the other concave mirror M_2, and is brought to a focus on the photographic plate at P. The concave mirrors are placed at their calculated distances and any necessary adjustment is then done by sliding in or out the slit until the image of the latter, when illuminated with Na. light, is perfectly sharp on the ground glass plate. Then, since the focal length of a mirror is independent of the colour of the light, all the spectrum is in focus away into the ultra-violet.

Suppose that a quartz prism is being used and that the photographic plate is replaced by a fixed eyepiece with crosswires. Then, if the mirror M_2 is adjusted so that the Na. lines coincide with the crosswires when they are at minimum deviation, and the prism table be rotated, every line comes into minimum deviation as it reaches the crosswires. That is, we obtain maximum definition automatically. The same holds if we are examining the infra-red with a linear thermopile. The thermopile remains fixed and we move the spectrum across it and every line as it reaches it moves into perfect focus, a pleasant contrast to the quartz spectroscope where, for every wave-length, we have to adjust both for minimum deviation and the correct distance of the thermopile from the lens.

Other advantages of this mirror spectroscope are its compact form and the absence of diffuse light. When light falls on a lens, eight per cent. is reflected back; here the light not used is absorbed by the mirror. Also, there are no tubes to reflect light at grazing incidence. The instrument may also be used as a monochromatic illuminator.

For the mirrors I have used plate glass and cheap concave lenses silvered. As it is the outside surface of the silver that is used, it is better to send the glass to an optical firm to be silvered. In calculating the position of M_1 and M_2 allowance must be made for the obliquity of the incidence. The correct distance between S and M_1 or P and M_2 is not r/2 but $\frac{r \cos \phi}{2}$ where ϕ is the angle between the incident beam of light and the normal to the mirror.

The disadvantage of silver mirrors is that they reflect light at 310 $\mu\mu$ very poorly. Consequently, that part of the spectrum is usually wanting, although the region beyond comes out well enough. Spiegel magnalium mirrors, however, reflect well to the very end of the spectrum; I have no experience of them, but, according to the tables, if they are used, the spectrum should be everywhere as bright as with quartz lenses.

A NATIVE IN MOURNING FOR A DOG.

BY the courtesy of Mr. Frederick Bonney we are enabled to publish the accompanying photograph of an old native woman of Australia who is shown in "half-mourning" (num-muyn-ka). Mourning consists of covering the head with plaster, and in half-mourning a broad band of the latter is put over the head from front to back. The remains of this are seen in the picture, the special interest of which is that the signs of sorrow were put on, not owing to the loss of a human relative, but on account of the death of a favourite dog.

After the period of mourning is over, the plaster must not be removed, but allowed to crumble away. Incidentally it may be said that the bag which the woman is netting is one that is usually carried suspended between the shoulders, the ends being tied under the chin. In such a bag, the women carry about small possessions or an infant if they are moving about with one.

The photograph was taken in April, 1881, at Momba, River Darling, New South Wales.

From a photograph *by Frederick Bonney.*

An Aboriginal Woman of Australia netting a bag.

The plaster on her head is the remains of half-mourning after the death of her dog.

SCIENCE IN EVERY-DAY LIFE.

By Rev. H. N. HUTCHINSON, B.A., F.G.S., F.Z.S.

"Knowledge grows, but wisdom lingers." These weighty words of the late Lord Tennyson are, perhaps, just as true now as when they were penned, over fifty years ago. Scientific knowledge has indeed advanced by leaps and bounds in that short space of time. The chemist, the astronomer, the student of physics, geology, or of biology, all stand now on a different foundation, and by the help of modern instruments and the wonderful results obtained by methods of precision, they are privileged to see a little further into the mysteries of the truly marvellous Kosmos in which we live, and to read, however imperfectly, some of the riddles of Nature. But when we ask whether the civilised races of mankind have made an equal progress in wisdom, we are obliged sorrowfully to confess that the answer must be in the negative. Were we truly wise we should endeavour seriously to apply some of all this scientific knowledge to the practical problems of every-day life. We ignore the teaching of Science as far as it touches our habits and ways of life. We do not think scientifically. A few individuals here and there may do so, but, as a nation, we certainly do not, and the consequences of this neglect are of a serious nature. In spite of the warnings of kindly Nature and the advice often offered, freely and with goodwill, by those who know and realize the importance of obeying her laws, and following her wise councils, we continue in our own foolish way; perversely making paths of our own that are dangerous, nay, even forbidden; doing some things in ways that are quite wrong, and others that ought not to be done at all. As the prophets of Israel solemnly warned the people of their day of moral evils, and of unrighteous ways, so men of science, in the twentieth century, may well take upon themselves some portion, at least, of the seer's duty, and speak in no uncertain tones of the misery and waste and suffering that follow from disobedience of Natural Law. Such warnings might well be graven deep on tablets of stone, and brought down from the sacred mountain of knowledge to the plains below, to be set up in the eyes of the people. We surely cannot dispense with the aid of Science: at every step we need her help—at our peril do we neglect her wise counsel. She is Athene to the modern Ulysses. When we enter the world, Science, in the person of a medical practitioner, stands by to help our arrival, and when we seem likely to leave it he is also there, in case he may possibly be able to keep death away, or at least to help us in our last moments. One may go a step further and say, that if the laws of heredity were considered in the making of matrimonial alliances, the health of the races could be vastly improved, and much quite unnecessary suffering avoided. The time will come when the science of Eugenics will take its proper place.

In the following pages, the writer begs humbly to offer a few thoughts and suggestions, to those who will accept them, in the hope that they may be of some service in a good cause. They are offered more especially to women—and doubtless the readers of "Knowledge" are not all men—because they refer largely to domestic matters, and, in the house, woman is rightly supreme. She it is who is responsible for order, cleanliness, comfort and the supply of food, light, air, and other things so truly vital to a proper healthy existence. There is hardly any limit to her power in this domain; in her hands lie the man's peace and perhaps his very life.

The first thing to consider is the house we live in, and its environment. Nobody would willingly choose an unhealthy place to live in, but supposing that circumstances compel us to dwell in such a district, we can at least see to it that our homes are not insanitary. It is a good plan, in these cases, to call in the aid of a professional expert, a sanitary engineer or an architect. All who study these matters are aware of the fact that houses have been built in situations where good health is hardly possible, except perhaps to a few exceptionally strong men and women, places where damp prevails, bringing with it lung troubles, rheumatism and a lowered vitality. In these places the death-rate is a high one. For example, the situations of our two chief Universities are bad—they would never have been chosen by their pious founders had they known something of the Science of Sanitation. It is to be hoped that, in the good days to come, the building of dwelling houses on such sites will be strictly forbidden, and on those which may be moderately unhealthy, only such houses should be allowed as are built on arches, as recommended by the late Dr. B. W. Richardson. This simple plan would keep out damp to a large extent. It is sad to think how many valuable lives are lost, or at least partly ruined, by neglect of these simple precautions, which even a slight knowledge of science would suggest. The writer has frequently seen country houses surrounded by so many trees at a short distance as to render them decidedly dark and unhealthy. Now darkness in a house is a thing to be carefully avoided. It is bad for the mind, because darkness is depressing, and all depressing influences should be avoided. It is bad hygienically, because evil germs flourish in darkness, while sunlight kills them.

Labour-saving appliances should be welcome in these days, when good servants are not easy to obtain (and are inclined to leave us after a year or two). But there is one plan which the present writer has often strongly advocated which, perhaps, more than any other, would save labour, and that is the provision of hot and cold water in every bedroom, together with a waste pipe of proper width to take away water which has been used, and other things. This idea is not new, for it is being carried out in

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some of the best and most up-to-date hotels, where labour-saving is most important.

Doubtless builders might object to the extra expense, but as soon as the public demand such a change it will be made. The only delay will be in educating people to make the demand. Linoleum might be used to a greater extent; most houses have too many carpets, curtains and other hangings which collect dust. On entering the house dirty boots bringing in mud might be changed for slippers.

The writer does not propose in these articles to discuss the action (or inaction) of corporate bodies, a subject on which much might be said, but it may suffice to point out the importance of scientific knowledge to our local rulers. The more they know of science, the fewer mistakes will they make. In spite of frequent warnings in the daily press, few people realize the dangers lurking in water and milk, two of the prime necessaries of life. The public are in the habit of drinking water anywhere and everywhere, without making any enquiries as to its purity and origin. A very good rule would be to refuse to drink the water provided in hotels, restaurants, or lodgings unless guaranteed to be effectively filtered. There are good filters to be obtained which will effectually stop all bacteria, if kept clean and in good working order, such as the "Pasteur" (which has been subjected by expert bacteriologists to severe tests). Perhaps a safer plan would be to boil all the drinking water, and charge it with carbonic acid in large gasogenes made for the purpose. This would make it pleasant and sparkling. When travelling abroad, it is still more important to avoid the drinking water, and to drink only wine or beer, or mineral waters of guaranteed quality. With regard to milk, it may be safely said that the danger is still greater; and one is glad to observe that more attention is now paid to this subject, both by the general public and by sanitary authorities, for it is a most serious question. Tuberculosis in children is frequently due to milk from a tuberculous cow. Diphtheria, scarlet fever, typhoid, may often be traced to a similar source. Consequently it is most important that both dairymen and farmers should take every reasonable precaution to keep the milk clean and pure, for it is a most favourable soil for harmful bacteria. Also milk, when it reaches the house, should be kept in a cool place, away from the sun, and it is a good plan to cover the basin containing it with muslin (fixed on a wooden hoop), to keep out flies and dust. Dairymen mostly adopt this practice now, and housekeepers should follow their example. Most farmers are not sufficiently careful about the condition of the cow-house and its surroundings. Any sort of refuse carelessly left near these places may be a real source of danger, on account of the flies that breed on refuse heaps. Milkers must keep their hands clean, and milk-pails must be scalded with pure water. Sir James Crichton-Browne and others have spoken plainly to the public on the danger of flies, and it is greatly to be hoped that these warnings will be heeded. Some of the London streets might be washed and brushed very much more than they are. Where there is much traffic, one often sees horse manure lying about in large quantities. Flies are attracted to it, and when dried by the sun and air it is carried about like dust, enters shops where food is sold, and contaminates it. This is a matter in which doctors and public men may do good service to their fellow-citizens, by writing to the newspapers and bringing pressure to bear on local authorities. The power of the press is enormous, and consequently the education of our very unscientific public, in these days, is largely in the hands of the journalists; on them rests a heavy responsibility. One is glad to see a popular newspaper, such as the *Daily Mail*, devoting some of its space to matters of this kind, for in so doing it renders the nation a service of untold value.

It cannot be denied that a great deal of food is wasted, not by any one class of people, but in houses of all classes. Waste of any kind is unscientific, and quite wrong economically. One of the triumphs of modern science is the way in which bye-products, or so-called "waste," in manufacturing processes, have been turned to account and made a source of increased profit. Even the refuse from our houses can be converted into "producer gas," and supply gas engines for working machines, or for making electricity. What can be accomplished on a large scale can also be carried out on a small one, and, probably, more effectively. A great deal of teaching is wanted to bring home to the minds of women the full meaning of all this waste.

It is true that much care and supervision is needed in order to prevent waste, but the lady of the house (or housekeeper, as the case may be) should regard this as an imperative duty. Where coal fires are used (and these are quite wrong scientifically, as will be shown later) a good deal of valuable coal is wasted by servants, who are too careless or indolent to separate the white ashes from the unburnt coal, and so both alike are thrown into the dust-bin, to mix with organic refuse, such as cabbage leaves, and so on. To anybody who regards this question scientifically, it is quite clear that the organic matter and the inorganic matter should be strictly kept apart from the beginning. In the country, cottagers set a good example in this matter by putting coal ashes on to flower-beds, or some other part of the garden, and keeping the waste food-stuffs to feed a pig or chickens. Now it may be troublesome for town-folk to make this separation, but it would be well worth while to do it, and so to increase the national wealth and welfare. There should be two dustbins, one for coal ash (*i.e.*, real ash, not lumps of coal), pieces of china, wood, iron, paper and other such refuse; the other for food-stuffs. The lady of the house should give instructions to her servants to use a sieve for separating the coal ashes from unburnt coal, the former to be thrown away (which seems a pity, for they contain potash, soda, lime and iron silica, and so on, all of which can be used by plants; in country

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houses these should be put on one side for the garden). The latter should be used for making up the fire. The other bin may be used for organic refuse such as cabbage leaves and stalks, lettuce leaves, potato peelings and pieces of unused vegetables (tea leaves are often kept for use in sweeping floors), bones, after being used for soups, bits of meat. Bread and toast should never be thrown away, as they often are, even in the streets of the poor. All these things are to be regarded as valuable bye-products of the house. Some means ought to be devised for regularly collecting this matter from house to house; attempts in this direction are being made here and there by the Salvation Army and certain Sisters of Mercy. We presume that soup is made of this material, but a far better plan would be to use it for pig-feeding, in which way it would be more completely used and converted into bacon (which, at present, commands a high price).

The keeping of pigs by country labourers, farmers and others would thus be encouraged. The local authorities in towns, who at present take away all the house refuse, would be extremely glad to see such a change as this, for their carts would only be required to take away the inorganic matter, and thus much trouble and expense would be avoided, and that would mean a saving in rates (which in most places are rapidly rising). On the other hand, municipal piggeries might be worth considering.

Ladies might well devote more attention to the subject of food and diet. Our health depends partly on the food we eat, and the way it is kept and prepared. It may safely be stated that the hygiene of the larder and scullery in most houses is somewhat neglected. Meat guards might be used much more extensively. Rats and mice should be ruthlessly exterminated, as well as cockroaches and flies. Tinned meats should be avoided, especially tinned lobsters, oysters, shrimp paste, and so on. Even tinned fruits are not quite safe. Meats are now often done up in glasses, but air occasionally finds its way into these, causing decomposition. Ladies who do not study the hygiene of food would be surprised if they knew of the dangers that lurk in tinned foods. A good plan would be to give a general order to the cook that no such preparations be allowed to enter the house. Raw oysters are by no means safe—they should be cooked, and so should escallops and mussels; the latter are very wholesome and nourishing. Wholemeal bread is far preferable to the ordinary white kind, which unfortunately lacks some of the most important constituents of the wheat grains.

Steam cookers both for meat and vegetables should be used; in this way valuable salts and juices are retained, which by ordinary methods are lost.

The adulteration of food is a subject on which much instruction is wanted. More public analysts and public inspectors are greatly needed. Magistrates should inflict severe sentences in those cases where the evil-doers are brought to justice. In all our large towns a great deal of diseased meat is sold to the poor, especially in the form of sausages. Vegetarians avoid these dangers, and they set a good example; but those who do not wish to abandon a diet of flesh might well take less of it, and pay more attention to fruits, vegetables, milk and cheese, which are quite sufficient to keep us in health. We should then hear less about ptomaine poisoning, which is frequently connected with the eating of pork-pies. Fruits might be used by all classes a great deal more. Every country in the world can send its fruits to Great Britain and Ireland free of any tax. This is a great national blessing, and one which is hardly appreciated as it ought to be. Young people might be encouraged by their parents to eat apples, oranges, grapes, nuts, figs, raisins, dates, plums, currants, and so on, and at the same time to consume less of pastry, sweets, pickles and sauces. Parents may reply that many fruits are expensive. To this we may say, apples and oranges can be obtained cheaply by buying in large quantities, especially from the stores. The very finest apples, for example, can be purchased at about 1¼d. each by buying a large box containing about one hundred and twenty. The same with oranges. The fruit may easily be stored on wooden shelves in a wine cellar, and the riper ones picked out for present consumption, leaving the rest to ripen gradually for a month or two. They do far more good to the young people than medicines. Their use tends to keep down doctor's bills. Unfortunately, the less educated portion of the public still puts great faith in patent medicines and patent foods, and their credulity is incomprehensible; lying advertisements, and the promises held out therein, are accepted with a faith that is simply amazing. Nothing but education can stop this growing evil, for no Government has the courage to warn foolish people in such matters! Much might be said about the excessive use of stimulants, narcotics and drugs, but it is impossible to deal adequately with the subject here. Suffice it to say, that for most people the less alcohol they consume the better. Many old people have attributed their long lives to total abstinence. Even the doctors are much less in favour of alcohol than in former times. But with regard to tea and coffee much might be said; only we fear the ladies will not thank us for saying that the excessive use of tea (and coffee) by all classes is really a grave danger! It is taken far too strong and too frequently, and it should be poured off into another vessel after standing three or four minutes. Medical men are beginning to realize the magnitude of this evil. On all sides we hear of people suffering from "nerves," and yet they continue drinking large quantities of tea. When to these habits they add want of exercise, excessive eating (often of over-rich food, highly spiced with sauces), and somewhat idle habits, what wonder is it that they become depressed, morbid and unhappy? When the mind is left uncultivated by the very best literature and art, the effects are still worse.

(To be continued).

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BIRD LIFE ON THE CAERNARVON COAST. MARITIME HABITS OF THE LAPWING, RESEMBLING THOSE OF THE RINGED PLOVER.

By A. R. HORWOOD

(Leicester Museum).

WHEN staying for a few weeks on the Caernarvonshire coast at Criccieth, and engaged in the study of the habits of the different shore-birds and those frequenting the mouths of estuaries, I came across the nest of a Lapwing (*Vanellus vulgaris*) containing five eggs, which were generally unlike the ordinary type of plover's egg, in being both shorter and broader. All the eggs were similar in shape, and the coloration and markings were normal, but of course the number (five) was unusual.

Likewise the nest was quite characteristic, though more carefully constructed than is often the case in inland stations, consisting of more ample material, being composed of dried bents. It was placed at the edge of the coarse grasses, *Festuca, Agropyron*, and so on, fringing the sandy beach. This was not more than a dozen yards from high-water mark. Between the line of vegetation and the sea there were patches of shingle. Amongst the pebbles forming the shingle, the Lesser Tern breeds; and among the fine and sandy stretches removed some distance from the beat of the surf the Ringed Plover nests, whilst lower down still, in coarser sand and shell fragments, quite close to the water's edge, nests of the Oyster Catcher could be found. Indeed these three species (all of different genera) form a more or less constant avian association characteristic of low-lying littoral flats, especially along the western coasts of the British Isles.

When discovered, the Lapwing's eggs were warm, indicating that the bird had but just left the nest. Here it might be urged that the eggs were warm owing to the heat of the sun, and that the Lapwing is in the habit of leaving her eggs for the sun to hatch, but this would not obtain in this instance, as the day was dull, if not chilly, and, moreover, we do not credit this belief. No bird at least had risen up from this bit of coast, upon which I had been reconnoitring for some time, having beached the boat by which I had approached it. And for a considerable period I had been experimenting in the search for nests of the Ringed Plover, Lesser Tern, and Oyster Catcher, a good lesson in bird habits.

Now it is well known that the Ringed Plover does *not* get up and fly away at once, or circle round and round an intruder upon the approach of a human being to the vicinity of its nest. But, on the other hand, it simply leaves the nest unobserved (if possible), effecting this by running in and out of the piled-up masses of parti-coloured shingle which in plumage it closely resembles. Then, having removed to some distance, it may be noticed perched upon one of the rolled pebbles which strew the beach in great profusion. This manoeuvre may be followed easily and closely by one conversant with the habits of these birds, and is most marked, contrasting as it does in so noticeable a manner with the habits of the Lesser Tern.

Likewise, inland, the habit of the Lapwing when its nest is approached by a person—even some distance away, it may be, from the actual whereabouts of the nest—is totally different. For on first observing the intruder it quietly runs unseen for some little distance, then as quickly and stealthily takes wing, and, circling at first round and round the intruder, it repeatedly tries to inveigle him further and further away from its nest by sweeping backwards and forwards at a point and in a direction as far as possible removed from the nest; and now, appearing above the top of some hedge close by, it undoubtedly endeavours, by its anxious noise and vigorous flights to and fro, to try and decoy the enemy away.

Not so, however, when nesting along the sea-coast, for here it has undoubtedly habits similar to those of its somewhat near relative, the Ringed Plover; and, instead of getting up some distance from the nest, it runs along, remaining, like the Ringed Plover, at a distance amongst the shingle until the danger is past. This, moreover, is easily accomplished amongst the bushy grasses at the edge of which it nests. Though *several* nests were found in the same locality under similar conditions, no birds were seen.

Somewhat exercised in mind as to how to account for this evident change of habit of the Lapwing when nesting on the sea-coast, as compared with its well-known and curious behaviour when breeding inland, and nesting on pasture or ploughed land, and not knowing whether or not my experience was unique, upon my return to Shropshire, where I was then living, I mentioned this interesting habit of the Lapwing to Mr. H. E. Forrest, of Shrewsbury, who was then, as now, particularly interested in the fauna of North Wales (of which his recent work is perhaps a summary). I was naturally surprised but delighted to find that he was able to bear out my experience, when I related the circumstance to

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him, though he had not, until I pointed out the resemblance in habit between the Lapwing and the Ringed Plover, noticed that this was the case. Mr. Forrest wrote me as follows: "I was struck by your remarks as to the behaviour of Peewits nesting by the sea. Though I hardly noticed it at the time, I should say, is of long standing. It is a curious fact that the Ringed Plover's tactics are identical along the sea-coast. Is this mere coincidence, or were the habits of the Lapwing originally like those of the Ringed Plover, and has it modified its breeding habits when nesting inland? Its migratory habits

From a Photograph by E. B. Miles *of Drawing by W. A. G. Montgomery.*

Lapwing, Ringed Plover, Oyster Tern and Little Tern, nesting together.

now remember that they leave the nest quite unobserved, and do not fly around in the way we always see them inland."

It seems probable, from the uniform shape of the five eggs found, that the Lapwing nests habitually in the same situation at the locality named, and that the habit it has acquired, or exhibits, perhaps we and generally conspicuous appearance rather suggest that once it was generally a frequenter of marshy tracts or areas not given over to cultivation, and indeed we must remember that it is only of comparatively recent years that cultivation has been general in the way that it is now carried on. At least the case is interesting.

ANNOUNCEMENTS.

THE PHYSICAL SOCIETY OF LONDON.—We are informed that owing to an alteration in the publications, papers read before the Physical Society of London in future will appear in general only in the *Proceedings* of the Society and not in the *Philosophical Magazine*. The *Proceedings* and other publications are now obtainable by the public from the publishers to the Society, The Electrician Printing and Publishing Company, Ltd., 1, 2 and 3, Salisbury Court, Fleet Street, London, E.C.

THE BRITISH ASSOCIATION.—For the meeting of the British Association for the Advancement of Science, which is to take place this year at Portsmouth, on August 30th, and following days, under the presidency of Professor Sir William Ramsay, K.C.B., F.R.S., the following presidents have been appointed to the various sections: Mathematical and Physical Science, Professor H. H. Turner, D.Sc., F.R.S.; Chemistry, Professor J. Walker, D.Sc., F.R.S.; Geology, A. Harker, M.A., F.R.S.; Zoölogy, Professor D'Arcy W. Thompson, C.B.; Geography, Col. C. F. Close, R.E., C.M.G.; Economic Science and Statistics, Hon. W. Pember Reeves; Engineering, Professor J. H. Biles, LL.D.; Anthropology, Dr. W. H. R. Rivers, F.R.S.; Physiology, Professor J. S. Macdonald; Botany, Professor F. E. Weiss, D.Sc., with W. Bateson, F.R.S., as chairman of the sub-section of Agriculture; Educational Science, Right Rev. J. E. C. Welldon, D.D.

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NOTES UPON THE FUNDAMENTAL SYSTEM OF STARS.

By F. A. BELLAMY, Hon. M.A., F.R.A.S.

Of all the branches into which astronomical work may be divided there is none of greater importance, none to which more time has been devoted at the observatories during the past two hundred and fifty years, and none that has proved so useful in our daily life, as meridional or star-catalogue work. Some hundreds of star-catalogues exist, small or great, and the aim of all has been to re-observe the brighter stars and obtain improved positions, and to observe and determine the positions of other and fainter stars; the object being to fix or ascertain a large number of points of reference in the sky, much as geographers do upon the earth.

The object of these notes is to draw attention to perhaps the most important piece of work ever undertaken in this branch, and to place before our readers a general summary of the proceedings which led to its being started, and of the present condition or progress already made.

Some remarks will be made upon the scheme proposed, the pecuniary and other help received by the Dudley Observatory, the erection of a southern observatory, the inauguration of the work there, also attention will be called to future proposals and ultimate aims; and, finally, a translation from the Spanish of an important paper by Professor R. H. Tucker, dealing with the actual details of the work and its progress at San Luiz, in Argentina, up to last July, will be appended.

The success of the great scheme depends upon three sources: Professor Boss, who has initiated, planned, and is naturally at the head of the work; Professor R. H. Tucker, the most eminent meridian worker, who has charge of the observational part; and the Trustees of the Carnegie Institution of Washington, who have provided the money.

The headquarters of the work will be at the Dudley Observatory, whose director is Professor Boss; the thousands of stars selected for observation were first observed there, then the same meridian instrument was taken to the southern observatory at San Luiz, and when the instrument has been returned to Albany, the stars at first observed there will be re-observed. There are various excellent reasons why this should be done.

The Dudley Observatory, near Albany, U.S.A., was founded in 1851, by subscription, principally aided by the generous donation of Mrs. B. Dudley—hence its name. It was organised in 1856, and placed under the direction of Dr. B. A. Gould. Until 1877 it was chiefly a meteorological observatory, but in 1878 a section of the Astronomische Gesellschaft scheme for the re-observation of all the Bonn Durchmusterung stars as bright as the ninth magnitude, and a considerable selection of others a few tenths of a magnitude fainter, was undertaken at the Observatory; the work of re-observing 8,241 stars between $+5^{\circ}\ 10'$ was commenced on August 19th, 1878, and completed on August 5th, 1882; each star was observed twice or more times. Professor Boss was engaged on the Zone observations and reductions throughout; the assistants, O. H. Landreth, T. D. Palmer, and R. H. Tucker were helping for one, three and four years respectively. Of Mr. Tucker, who was in charge of the whole work during Professor Boss's absence in Chili to observe the Transit of Venus, in December, 1882, the Director has acknowledged that "the record of observation and computation bears, throughout, high testimony to the character of his efficiency and zeal." This catalogue of 8,241 stars was published in 1890 and was one of the first two published in connection with that great and important scheme. It was accomplished by means of the Olcott Meridian Circle—so named from a generous donor of funds—constructed by Pistor & Martins of Berlin, in 1856, and is of eight inches aperture and ten feet focal length.

The position of the Observatory there was $4^{h}\ 54^{m}\ 59^{s}\cdot2$ W. of Greenwich and $42^{\circ}\ 39'\ 49''\cdot5$ north latitude; it was one hundred and seventy feet above the sea and situated on the northern side of the city of Albany in the valley of the Hudson river. Owing to the smoke and disturbance from engines and trains from the railway and from the frequence of local mist and fog, good work was interfered with, so much so that it seemed advisable, if not imperative, that the observatory be refounded on a new site; the money was forthcoming — as is usual for astronomy in the U.S.A.—and about 1893 the observatory was rebuilt on its present site, not very far from its original locality. Besides the Olcott Circle its other chief instrument is an equatorial telescope of twelve-and-a-quarter inches aperture by Brashear, Warner & Swassey. The exigencies of the meridian work have prevented the equatorial being much used. It is this Olcott Circle that has been temporarily moved to San Luiz.

Since the Observatory has been under the direction of Professor Lewis Boss, the chief work has been meridian observations, researches upon proper motions, and motion of the solar system. The most recent work has been the observation and preparation of a catalogue of positions and proper motions of all stars to the seventh magnitude, in connection with the department of Meridian Astrometry of the Carnegie Institution of Washington, which Institution has appropriated to the Dudley Observatory,

under grant No. 100, £1,000 for:—(1) The completion and publication of a catalogue of about 10,000 stars, 8,000 being between declination −20° to −37°, to the 7·5 magnitude; these observations were made between 1896 and 1901; (2) For the homogeneous determination of star positions and motions, computed and discussed from all available observations and star catalogues, to the sixth and in some cases to the 7·5 magnitude, with an accuracy of the highest possible order. This Preliminary General Catalogue, formed from various sources, has now been published; it contains the positions of 6,188 stars reduced to the epoch 1900·0 and includes results which are primarily designed to furnish a large number of systematically and accurately observed motions of stars. The intention was to include all stars that seemed to show a proper motion of 10″ a century, derived from observations made at various observatories. In January, 1902, Professor Boss again made application to the Trustees of the Carnegie Institution for aid in a general investigation of both the nature and amount of the motions of the stars. Specific things proposed to be investigated were (*a*) the direction and velocity of the solar motion in space to be determined with far more accuracy than at present known; (*b*) to investigate the subject of "star-swarms,"—swarms of stars moving in a common direction like meteors—a new subject, to which Professor Boss has been specially attracted; (*c*) to determine with accuracy the relative distance of various orders of stars; (*d*) to determine the constant of precession more accurately than is now known; and to examine other questions as they arise. Professor Boss considered that, as the basis of these investigations, the motions of the stars must first be accurately known, and that this would be both the greater and the most laborious part of the work. It is with this general investigation and the specific investigation (*a*), that Professor Boss and his staff have been progressing to the extent to be indicated later.

The fact of so much having been already accomplished served to prove beyond doubt to Professor Boss that the real value of his results to that period, about 1904, and of the final discussion, will depend upon the systematic accuracy of these determinations of motion, and upon having a good determination of motion for each star. Both these requirements called for further special observations, the great need in this direction being a new determination of the positions of the standard stars, distributed from the north to the south pole of the sky. Professor Boss' plan proposed to the Carnegie Institution was further supported by those results. The Dudley Observatory Meridian Circle was then being altered to meet his views with regard to such standard work. Aided by a grant, the first series of re-observation of the selected standard stars or points of ultimate reference, would be completed at Albany within about two years; after that he proposed to dismount the instrument and re-erect it upon a suitable site in the Southern Hemisphere. The places he had selected as eminently suitable were San Luiz, in Argentina, specially recommended by Mr. Davis, the chief of the meteorological service, as possessing an excellent and steady climate; another was Bloemfontein, in South Africa, highly recommended by Sir D. Gill, and places in Australia were also suggested. The idea in selecting a southern station was to observe stars at Albany from the north pole to as far south as possible, and then to use the southern observatory for observing stars from the Albany zenith to the south pole, and so interweave the two series that the elimination of systematic errors of observation might be effected by making them work in opposite directions in the two positions of the instrument. As a necessary addition to this proposal it was further urged that special re-observations be made of those stars, mostly south stars, which had been neglected during the past twenty to thirty years; the accuracy of the places of these particular stars is much desired in order to obtain improved knowledge of their proper motions, and so help to bring up the quality of their places to approximate that of the standard stars. Professor Boss said that in one-fourth of the southern sky, that near the southern pole, only thirty *per centum* of the stars to the seventh magnitude had been accurately observed since 1880, and scarcely any since 1894; the need of their re-observation was, therefore, very great and urgent.

In connection with the Carnegie Institution's desire for the establishment of a southern observatory it was proposed by Professor Boss, and warmly supported by eminent astronomers, that his particular scheme of research work, essentially referred to in (*a*)—the re-observation and determination of standard positions of a large number of stars from the north to the south poles of the sky—was specially that kind of work for which a portion of the funds of that Institution could be most appropriately utilized, especially as the qualifications, time, and energies of several astronomers were now available for carrying out such a grand scheme. In making this application to the Institution, Professor Boss said he would use the same instrument as employed at Albany, which he considered to be one of the finest meridian instruments in the world for such work, and one in which the investigation of the division-errors of its circles has been accomplished with the highest degree of accuracy, by the combined labours of four observers lasting more than a year. He proposed to take personal charge of and responsibility for the whole of the investigations both for the northern and for the proposed southern observatory; and intended to go to the Southern Hemisphere to organize the work, to remain there for a time in order to ensure its smooth, speedy, and accurate running, and, towards the end of the southern series of observations, to re-visit that observatory to satisfy himself and colleagues that no point of importance had been neglected. In making his application for a grant to carry out his plans of 1902, in their most complete and satisfactory manner, he specially drew

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attention to, and emphasized, the fact that this observational portion and its reduction to standard points of reference, was both the most costly and the most laborious of the four items for investigation proposed for the Institution's kindly interest and pecuniary support.

The Board of Trustees of the Carnegie Institution agreed to aid Professor Boss, and, under grant No. 479, £5,000 was appropriated for the use of the Department of Meridian Astrometry, to be directed by Professor Boss at the Dudley Observatory, Albany, New York, for "*study of motion and structure of the stellar system of the Northern and Southern Hemispheres.*"

Work upon this larger General Catalogue of about 25,000 stars, was commenced at Albany at the earliest moment in 1907, October 7th, and by the end of 1908, August 15th, or after ten months' work, 10,421 meridian observations were obtained with the Olcott Circle. They were chiefly made by the two assistants, Mr. A. J. Roy and Mr. W. B. Varnum, whose zeal, loyalty, and efficiency, as Professor Boss specially testifies, is worthy of all praise. Eight others have also assisted in the work at Albany. These observations were made upon a fundamental system, and are mostly of standard stars between 83° north zenith distance and 40° of south declination. All the stars visible from the Albany zenith to this south declination can also be observed at the finally-adopted site of the southern observatory at San Luiz, latitude—33° 18′ and longitude 66°·3 or $4^h\ 25^m\ 25^s$ W. of Greenwich. So soon as the favourable conditions of the climate were ascertained, and it had been decided that San Luiz, in Argentina, should be the site for the southern observatory, progress was made with the preparations for the establishment of the observatory during 1907 and 1908. San Luiz is a town of about ten thousand inhabitants, and is situated on the Trans-Andean Railway, about five hundred miles inland or west of Buenos Aires, and at an altitude of two thousand five hundred feet above sea level. The site is not near enough to the Andes to get influenced by the intense and oppressive heat waves of the Andean plains.

The U.S. Department of State, through the courteous and cordial interest of the Secretary of State, Mr. E. Root, was specially helpful in arranging matters with the Argentine minister, Senor Don E. Portela, who interceded and induced the Argentine Government to facilitate the choice of a site, for various permissions, and for other privileges.

By the valuable influence, interest, and courtesy of Mr. W. G. Davis, Director of the Meteorological Department in Argentina, Dr. L. S. Rowe, Mr. De la Plata, Mr. Naón, and Mr. Ezcurres, Ministers of Foreign Affairs, of Justice, of Public Instruction, and of Agriculture respectively, they were saved much trouble and expense in the entry of the instruments, in their free conveyance to San Luiz, in free tickets for the observers, and in the free use of a site on national property of the Escuela Regional (San Luiz), which is under the direction of Dr. C. L. Newton.

So the Argentine authorities—especially those at San Luiz—having entered thus heartily into the matter, it was possible for Professor Boss, with Professor R. H. Tucker and Mr. W. B. Varnum, to sail in the SS. *Velasquez*, on August 20th, 1908; they arrived at Buenos Aires on September 13th, and at San Luiz on September 20th, where they were met by a party of official representatives of the Provincial Government of San Luiz, consisting of Senores Gazari, Quiroga and Romanella, and by many prominent citizens of San Luiz. Professor Boss and his colleagues at once proceeded to choose the actual site at San Luiz, to select the quarters for the observatory staff, offices, and so on, and to make general arrangements for the work. Certain instruments and portions of some of the constructive materials were taken out there by these astronomers. As soon as the ground could be prepared, and the construction of the observatory had been planned and started, Professor Boss returned to Buenos Aires on October 7th, leaving Professor Tucker and Mr. Varnum to take charge and superintend the erection.

On October 10th, Professor Boss sailed in the SS. *Velasquez* on his return to New York. On the sixth day out the ship ran at full speed upon the rocky coast of San Sebastian Island; the night was very dark, with rain and fog. The ship and its cargo became a total wreck, but after some dangers and hardships, all the passengers, crew, and most of their luggage were saved, and they proceeded to Santos, Brazil, from which port Professor Boss again started, in the SS. *Titian*, for New York, on November 11th.

(To be continued).

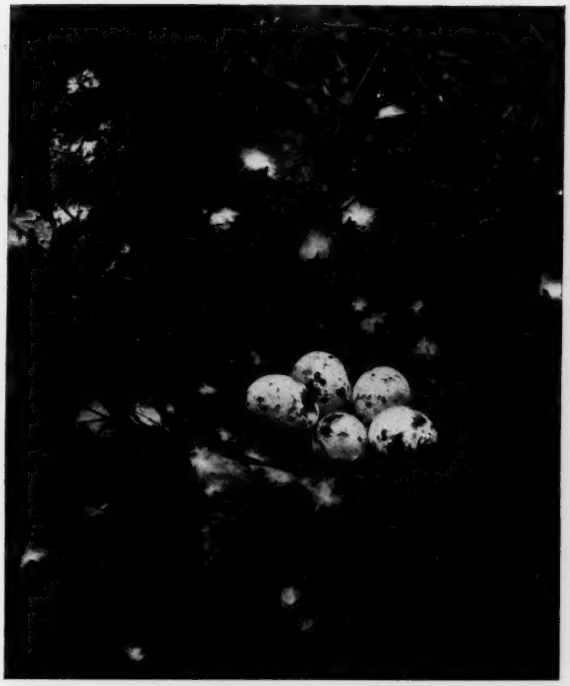
REISSNER'S FIBRE.

AT a recent meeting of the Linnean Society of London, Professor Dendy and Mr. G. E. Nicholls exhibited a series of lantern slides illustrating the structure and relation of the sub-commissural organ which has a sensory function in brains of various vertebrate types as well as of Reissner's fibre which runs from the sense organ down the spinal cord. The slides were described by Professor Dendy, while Mr. Nicholls gave a brief account of some experiments which he had made, which so far seemed to support the view that the organs in question constitute an apparatus for automatically regulating the flexure of the long axis of the body. Reissner's fibre does not apparently exist in man, though some traces of the sub-commissural organ occur in the embryo.

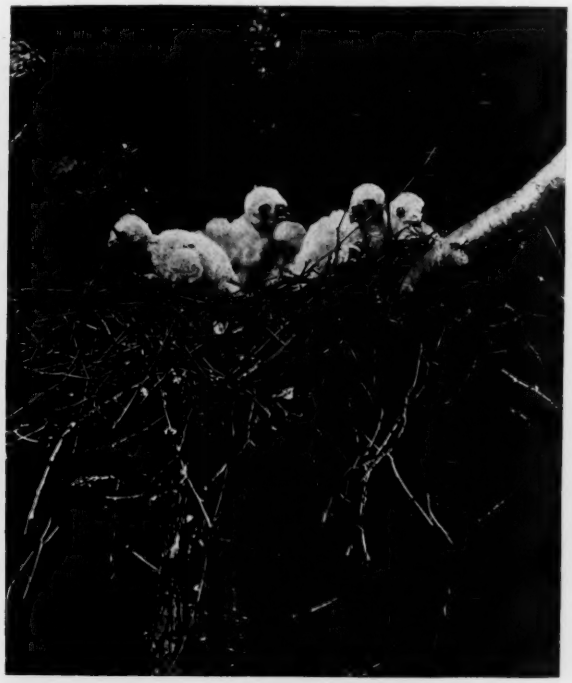
THE SPARROW HAWK *(Accipiter nisus).*

Illustrated from Photographs

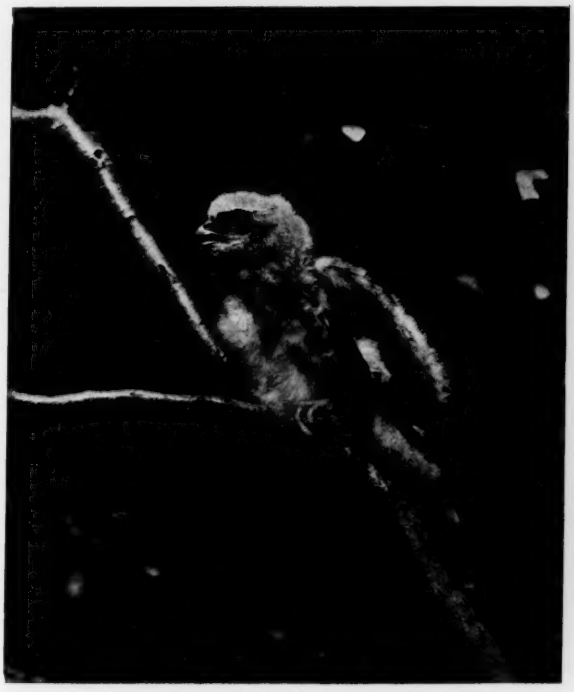
By ARTHUR BROOK.



Nest and Eggs.



Young in the Nest.



A nearly-fledged Bird.

The Hen on the Nest.

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NESTING SITES FOR BIRDS.

The boxes at the top of the page are on the same plan as those which have been used with great success in the Brent Valley Bird Sanctuary, but some improvements have been made in the way in which the lid opens and is fixed in place.

The boxes seen in the middle of the page are hollowed out from natural logs of the Birch, the tops can be removed so that they may be cleaned out or the contents examined from time to time.

The others shown at the bottom of the page are also made from natural logs, but in this case the centre is removed from the side instead of from the end, and after being hollowed out a second and a third time the piece is replaced once more in the log from which it can be pulled out like a drawer.

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THE ENCOURAGEMENT OF INSECT EATING BIRDS.

ALTHOUGH here and there in this country those who are fond of birds have furnished them with nesting sites, which is an important point in these days when it is not easy for many species that build in holes to find accommodation, yet no general attempt has been made as in some other countries definitely to encourage insect - eating birds, which are specially useful to those who are engaged in growing crops.

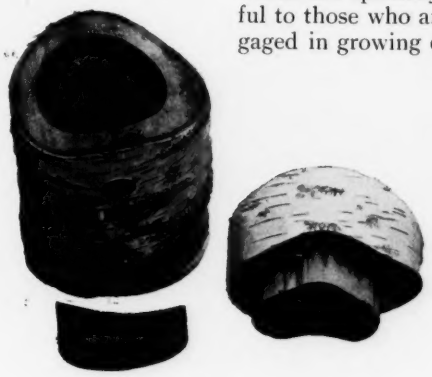

FIGURE 1.
The parts of a box made from a log so arranged that the top lifts off.

The Brent Valley Bird Sanctuary Committee have shown what can be done in the way of protecting birds on the borders of London, and with a view to making the movement in favour of attracting birds more general, they have introduced and are showing at various exhibitions a number of new designs for nesting boxes.

The Chairman of the Committee has contributed an article on the subject to *The Country Home* for March, and here and on the opposite page we give illustrations of some of the more important kinds of nesting sites with details of their construction.

The nesting sites made from boards have been used with great effect in the Sanctuary, but it seems that in gardens and near houses it might be advisable to use materials which are more natural and less suggestive of a trap. The ordinary boxes made from logs of which the tops come off, can easily be erected on posts, and are suitable for wrens and tits when they have a small opening, and for robins when the aperture is a little bigger. The latter birds sometimes prefer a box with an open front, and this is the case with flycatchers. Various boxes have been designed for their benefit (see Figures 3 and 4), and a modification of Figure 2 of which the upper half of the front of the movable piece has been cut right away. All particulars can be obtained from the Secretary of the Selborne Society, at 42, Bloomsbury Square, W.C.

FIGURE 2.
The parts of a nesting site in which the centre of the log can be drawn out.

FIGURE 3. FIGURE 4.
Two simple forms of open nesting boxes for birds which do not care to build in complete darkness, but which like protection from the rain.

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THE FACE OF THE SKY FOR MARCH.

By W. SHACKLETON, F.R.A.S., A.R.C.S.

THE SUN.—On the 1st the Sun rises at 6.49 and sets at 5.37; on the 31st he rises at 5.42 and sets at 6.27. The Sun enters the sign of Aries at 6 p.m. on the 21st, when Spring commences. Small groups of spots may usually be observed on the Sun's disc, but there has been a considerable falling off in solar activity, both as observed visually and spectroscopically; at the time of writing one small spot is visible. The positions of the Sun's axis, centre of disc, and heliographic longitude are given below:—

Date.	Axis inclined from N. point.	Centre of Disc S. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Mar. 2	21° 48′W	7° 14′	224° 24′
,, 7 ...	22° 58′W	7° 15′	158° 32′
,, 12 .	23° 59′W	7° 13′	92° 38′
,, 17 ...	24° 49′W	7° 7′	26° 44′
,, 22 ...	25° 29′W	6° 58′	320° 49′
,, 27 ...	25° 59′W	6° 46′	254° 53′
Apl. 1 ...	26° 18′W	6° 31′	188° 56′
,, 6 ..	26° 26′W	6° 13′	122° 58′

The Zodiacal light may be seen in the West, shortly after sunset. After the middle of the month is the best time for observation, as the Moon will not have risen, and the tapering glow may be seen for 30 or 40 degrees along the ecliptic.

THE MOON:—

Date.	Phases.	H. M.
Mar. 7 ...	☽ First Quarter	11 2 p.m.
,, 14 ...	○ Full Moon	11 59 p.m.
,, 23 ...	☾ Last Quarter	0 26 a.m.
,, 30 ..	● New Moon	0 38 p.m.
Apl. 6 ...	☽ First Quarter	5 55 a.m.
Mar. 6 ...	Perigee	4 30 p.m.
,, 21 ...	Apogee	1 6 p.m.
Apl. 2 ...	Perigee	8 12 a.m.

OCCULTATIONS.—The following are the principal occultations visible from Greenwich:—

Date.	Star's Name	Magnitude.	Disappearance.		Reappearance.	
			Mean Time.	Angle from N. point. E.	Mean Time.	Angle from N. point. E.
			p.m.		a.m.	
Mar. 6	A^1 Tauri ...	4·5	11.57	71°	0 47	270°
					p.m.	
,, 7	k Tauri ...	5·6	8.52	88°	9.57	260°
,, 10	ω^1 Cancri ...	6·1	5.38	32°	6.7	343°
,, 10	ω^2 Cancri ..	6·2	5.46	105°	6.58	272°

THE PLANETS.

MERCURY:—

Date.	Right Ascension.	Declination.
	h. m.	
Mar. 1 ..	21 50	S 15° 22′
,, 11 ...	22 55	9° 8′
,, 21 ...	0 5	S 0° 53′
,, 31 ...	1 16	N 8° 30′
Apl. 10 ...	2 20	N 16° 18′

Mercury is in superior conjunction with the Sun on the 20th, and is thus unobservable throughout the month.

VENUS:—

Date.	Right Ascension.	Declination.
	h. m.	
Mar. 1 ...	0 10	S 0° 3′
,, 11 ...	0 55	N 5° 8′
,, 21 ...	1 40	10° 8′
,, 31 ...	2 27	14° 44′
Apl. 10 ..	3 15	N 18° 45′

Venus is an evening star, and may be seen immediately after sunset, looking W., not very high above the horizon. Throughout the month the planet sets about 2½ hours after the Sun.

In the telescope the planet appears gibbous, about 0·9 of the disc being illuminated.

Conjunction of Venus and Moon, April 1st.

On March 2nd, the Moon appears near the planet, Venus being 2° 20′ to the North, but on April 1st, the two appear in still closer proximity as shown below, Venus at 5.45 p.m. being only 14′ to the North. The Moon will be only two days old, but if the weather is favourable it should be easy to see both the planet and Moon, quite early on in the twilight.

MARS:—

Date.	Right Ascension.	Declination.
	h. m.	
Mar. 1 ...	19 30	S 22° 34′
,, 11 ...	20 2	21° 24′
,, 21 ..	20 33	19° 53′
,, 31 ...	21 3	18° 3′
Apl. 10 ...	21 33	S 15° 55

Mars is visible for a short time in the early mornings, rising about 4.30 a.m., near the middle of the month. The planet is an inconspicuous object in Sagittarius, and is ill-suited for observing telescopically, as the apparent diameter is about 5″. The Martian equinox occurs on March 7th, when Spring commences in the Southern Hemisphere.

JUPITER:—

Date.	Right Ascension.	Declination.
	h. m.	
Mar. 1 ...	14 50	S 14° 58′
,, 11 ...	14 49	14° 54′
,, 21 ...	14 48	14° 44′
,, 31 ...	14 45	14° 29′
Apl. 10 ..	14 41	S 14° 11′

Jupiter rises in the E.S.E. at 11.30 p.m. on the 1st and at 9.25 p.m. on the 31st; is the most conspicuous object in the late evening sky looking East. The planet is describing a retrograde path in Libra about 1° N. of α Librae. The attendant bright moons can be seen in very small telescopes or even in a pair of binoculars magnifying 6 or 8 times, whilst the belts are also visible in small telescopes of about two inches aperture using a magnifying power of about 50. The equatorial diameter of the planet on the 19th is 41″·5,

whilst the polar diameter is 2″·7 smaller; this polar flattening is readily observed in telescopes powerful enough to see the belts.

In larger telescopes, markings on the belts may be observed; these rotate with the planet and recur in the same position every $9^h\ 55^m$ which is the planet's rotation period.

The following table gives the satellite phenomena visible in this country before midnight:—

Date.	Satellite.	Phenomenon.	P.M.'s. H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.
Mar.				Mar.				Mar.			
8	I.	Sh. E.	11 37	23	I.	Ec. D.	10 34	31	I.	Sh. I.	9 34
16	I.	Oc. R.	11 46	24	I.	Tr. E.	10 40	31	I.	Tr. I.	10 16
21	II.	Tr. I.	11 50	30	II.	Oc. R.	10 56	31	I.	Sh. E.	11 46

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its reappearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress; "Ec. D." denotes disappearance of Satellite by Eclipse.

SATURN:—

Date.	Right Ascension.	Declination.
	h. m.	
Mar. 1 ...	2 5	N 10° 16′
,, 16 ...	2 11	10° 49′
Apl. 1 ...	2 18	N 11° 28′

Saturn is only observable for a short time each evening during the month, as he sets at 10.28 p.m. on the first and at 8.45 on the 31st. The planet appears as a fairly bright star looking nearly due West as soon as it is dark. Observed in the telescope, the ring appears wide open, as we are looking on the Southern surface at an angle of 18°. The apparent diameter of the outer major and minor axes of the ring are 39″ and 12″ respectively, whilst the diameter of the ball is 15″.

The Moon appears near the planet on the evenings of the 4th and the 31st, whilst Venus appears in proximity on the 29th.

URANUS:—

Date.	Right Ascension.	Declination.
	h. m. s.	
Mar. 1 ...	19 59 36	S 21° 7′ 15″
Apl. 1 ...	20 4 34	S 20° 53′ 48″

Uranus is visible in the early morning, rising about 4.15 a.m. near the middle of the month.

NEPTUNE:—

Date.	Right Ascension.	Declination.
	h. m. s.	
Mar. 1 ...	7 21 56	N 21° 28′ 45″
Apl. 1 ...	7 20 55	N 21° 31′ 41″

Neptune is situated in Gemini about three-and-a-half degrees S.E. of the star δ Geminorum.

Near the middle of the month the planet is on the meridian about 7.45 p.m., and sets about 3.45 a.m. The planet is difficult to identify among the numerous small stars appearing in the same field of view, and as he is practically stationary this month he cannot readily be detected by his relative motion. Moreover, it requires a high power (about 300) and good definition to distinguish his disc.

METEOR SHOWERS:—

Date.	Radiant. R.A.	Radiant. Dec.	Near to	Characteristics
	h. m.			
Mar. 1-4 ..	11 4	+ 4°	τ Leonis	Slow; bright.
,, 14 ...	16 40	+54°	μ Draconis	Swift.
,, 24 ...	10 44	+58°	β Ursae Maj	Swift.

Minima of Algol occur on the 11th at 10.21 p.m., and on the 14th at 7.10 p.m. Its period is $2^d\ 20^h\ 49^m$, by which other minima may be deduced.

Double Stars.—γ Leonis, $X.^h\ 14^m$, N. 20° 22′, mags. 2, 4; separation 3″·8. In steady air, the prime requisite for double star observations, this double may be well seen in a 3-in. telescope with an eyepiece magnifying about 30 to the inch of aperture, but on most nights one with a power of 40 is better. The brighter component is of a bright orange tint, whilst the fainter is more yellow.

ι Leonis $XI.^h\ 19^m$, N. 11° 5′. mags. 4, 7½; separation 2″·2. A pretty double of different-coloured stars, the brighter being yellow, the other blue. This object requires a favourable night and a fairly high power on small telescopes.

α Leonis (*Regulus*) has a small attendant about 180″ distant, magnitude 8·5, and easily seen in a 3-inch telescope.

α Canum Venat (*Cor Caroli*), $XII.^h\ 52^m$, N. 38° 49′, mags. 2·5, 6·5, separation 20″. Easy double; can be seen with moderately low powers, even in 2-in. telescopes.

CORRESPONDENCE.

COLOURS ON THE ECLIPSED MOON.

To the Editors of "KNOWLEDGE."

SIRS,—I think I remember a recent question in "KNOWLEDGE" to this effect: "What would be the distance of the red light from the sun refracted through the earth's atmosphere, regarding this as a lens stopped down by a large central circular disc," and I think this had reference to the colours on the surface of the moon in eclipse. Now the action is quite unlike that of any lens because the density of the air diminishes from the surface upwards. Regarding the sun as a point of light, the focus for red rays passing close to the surface of the earth would fall at a point somewhat nearer than the moon's distance, and the difference of position for any other coloured light would be very small, but the light which passed through the outermost layer of the atmosphere would fall only just inside the vertex of the earth's geometrical conical shadow nearly a million miles away, and at every point between these extreme distances there would be a focus of some infinitesimal fraction of the light; moreover, the sun is not a point and the question is still more vague. The light which passes through the earth's atmosphere would cover a surface which, at the distance of the moon, would be very much larger than the moon's disc; the distribution of the light over this surface would not be uniform, and would be very slightly different for different colours, but this could not possibly produce any recognisable colour difference; the colours observed are due to a cause quite distinct from refraction. The green colour often noticed at the edge of the shadow before and after totality is no doubt due to the familiar subjective complementary colour-effect of the reddish light in the shadow, and the coppery colour in the shadow is due to the same cause which gives us a blue sky and a red rising and setting sun, namely, that light of short wave-length is much more reflected

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and scattered by small particles in the air—or according to Lord Rayleigh, by the molecules of the air itself—than the red rays with greater wave-length; and the light which reaches the eclipsed moon has passed through a depth of air about twice as great as that through which the light from a setting sun has passed.

The very great differences in the brightness of the eclipsed moon on different occasions is very curious, and though clouds over large surfaces on the earth might well cause considerable differences in the light, it seems hardly sufficient to account for it entirely.

J. H. G.

ARTIFICIAL MOCK SUNS.

To the Editors of "KNOWLEDGE."

SIRS,—At the end of November I had a view of four mock suns, and glimpses of five others, all, however, produced by a chance arrangement of windows. I was seated in a train travelling west along the north shore of the Lake of Geneva: it was between 2.30 and 3 p.m., and the low sun shone straight into the carriage.

There were three panes of glass between me and the outer air—viz.: (*a*) the glass window of the carriage; (*b*) the glass window of the corridor, distant about two-and-a-half feet from (*a*); and, between these (*c*) the window of the carriage door, which, being open and folded back, was about an inch distant from (*a*). On either side of the sun, and distant about five degrees, there appeared fainter, but still very bright, sun-images. Beyond each of these again, at the same distance, were faint sun-images. When the carriage was slightly tilted on a curve, fainter images were seen above each of these five suns, ten suns in all. The phenomenon was not visible from the corridor, and was pretty clearly caused by a reflection between the near panes (*a*) and (*c*). How far is this analogous to the mock suns of Polar explorers?

AGNES FRY.

THE ETERNAL RETURN.

To the Editors of "KNOWLEDGE."

SIRS,—In reply to your correspondent, Mr. H. D. Barclay, *re* the theory of Nietzche, I would suggest that much depends upon the meaning attached to the words "identical individual." Our *identity* consists of the consciousness of the continuation of our psychic reality, notwithstanding repeated entire material changes and replacings of our bodily organism. The indestructibility of the material constituting the organism is a possible conception, as also its adaptability to new combinations; but to assume that a re-combination of the precisely same elements will constitute the same being, is to assume that the identical psychical entity is not only dependent upon, but is absolutely produced by, that particular combination.

This is to grant eternity to matter, but to make the actual existence of mental phenomena subject to creation and destruction. Again, many misleading words are used in reference to force. To speak of the "sum total of force" is to give it "reality," to constitute it a tangible entity, having dimensions and duration, a power real and potent to move inert matter. But we know of no such force. "Matter and its activities" is the limit of physical science, force is the name of those activities. To give it occupation in space is to create it matter; "to pervade infinite space" is to exclude the possibility of other existence.

Mr. Barclay, I venture to think, is right in affirming that *absolute* vacant space seems unthinkable, though this may be so "in the absolute." Vacant space is not only thinkable, but an essential concomitant to material existence.

May we have better elucidations of this most interesting subject from more capable pens?

FRED GILMAN.

SOLAR DISTURBANCES DURING JANUARY, 1911.

By FRANK C. DENNETT.

THE great falling off in the number of outbreaks upon the solar surface was very marked during January. With the exception of the five days, the 4th, 5th, 17th, 21st and the 22nd, the sun has been examined every day. Upon the 19th, 20th, 25th, 27th and the 28th no trace of disturbance, bright or dark, could be found. On ten other dates faculae alone were to be seen. The longitude of the Central Meridian at noon on January the 1st was 294° 30′.

No. 1.—A spot first seen near the east limb on January the 3rd. There appeared to be two umbrae on the 7th, the larger being again cut across by a bright bridge; two pores were situated just behind it. One pore still there on the 8th, and the umbra bridged. On the 10th the bridged umbra seemed of a violet hue, and the filamented penumbra appeared to brighten inwards. The bright fringe, especially on equatorial side, still seen, as well as the bridging, on the 13th and the 14th, when the spot was evidently dwindling. On the 15th, when last seen, still bridged, the umbra seemed to be edged with brightness, but a penumbral wing stretched south-east. The greatest diameter of the spot was 15,000 miles. As it neared the western limb it became surrounded by faculae.

A group of faculae, A, like a companion outbreak to No. 1, seen on the 14th.

B and C, faculic ridges seen on the 14th–15th round the eastern limb, the latter seen again the 25th–26th, when approaching the western limb.

D, a small bright facula near the western limb on the 25th.

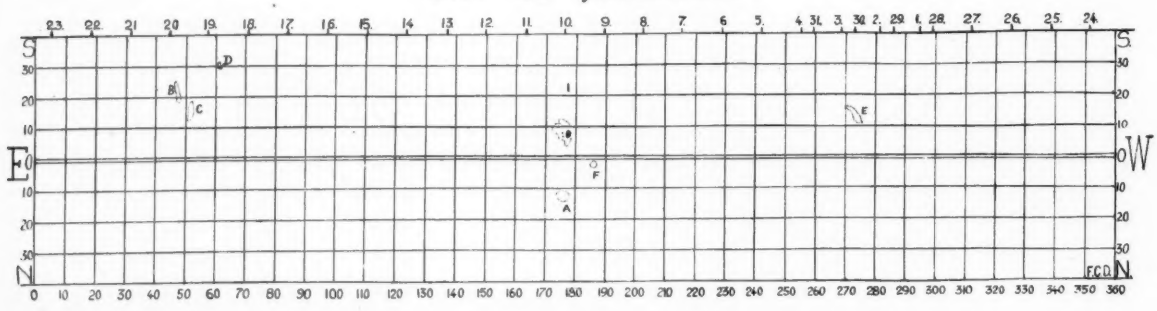
Near the eastern limb on the 25th a bright ridge, E, recorded.

A small faculic knot in a disturbed area, F, seen on the 31st.

This great falling off in the number of outbreaks seems to indicate that we are approaching the time of solar minimum. As one cycle ends the spots are as a whole nearer to the equator. The new cycle is usually indicated by the outbreak of spots far away from the equator, so that it is necessary to watch the outer boundaries of the spot-zones. It seems probable that the signs of returning activity may be noted in the northern zone.

The chart is constructed from the combined observations of Messrs. J. McHarg, A. A. Buss, E. E. Peacock, W. Strachan, and F. C. Dennett.

DAY OF JANUARY.



QUERIES AND ANSWERS.

Readers are invited to send in Questions and to answer the Queries which are printed on this page.

QUESTIONS.

Numbers 16, 17 and 18 (December number, page 461), 21 (January number, page 39), 26 and 27 (February number, page 49), still remain unanswered.

28. PALLAS AND *d* AQUARII.—On September 22nd last, at transit time, (a moderately good night, and Pallas being then of 9·1 magnitude), the Planetoid was quite mysteriously missing to the writer in the immediate neighbourhood of *d* Aquarii. Owing to bad weather and moonlight it had last been observed only on the 13th, and was again recovered on the 24th. As it had obviously closely approached *d* Aquarii would some one of your astronomical readers care to very kindly give me its position-angle and distance from the named star at transit on 22nd September, or, failing that, either the apparent place for the date of the star, or a 1910 mean-place?

I should also feel very grateful for particulars of the magnitude, distance and position-angle of the small companion of *d*.

ASTEROID.

29. CONSTITUTION OF THE ATMOSPHERE IN WINTER.—As deciduous trees and plants do not elaborate O, nor consume CO_2 during the winter, have any experiments shown that there is a deficiency of O, or a preponderance of CO_2 during this season?

W. HARMAN.

30. FINDING THE TIME BY THE HEAVENLY BODIES.—I have been much interested in the recent correspondence on finding the time by night through observation of the stars.

Might I ask whether any of your readers can go further and inform me on the following problems connected with the time by day?

(1) How can the time of the day be ascertained by measuring the ratio of the length of a stick to that of its shadow? As an example, imagine this ratio to be one-half on May 1st, what is the time?

(2) At what times in the year will the length of a stick be the same as that of its shadow at noon?
In both instances I assume the latitude of London.

(3) Can the latitude of a place be determined by comparing the ratio between the length of a stick and that of its shadow at noon?

INTERESTED.

31. WIRELESS TELEGRAPHY AND THE WEATHER.—I have heard it stated that wireless telegraphy may be, to a certain extent, responsible for changes in weather. Can any scientific reason be given for this if it be true?

JOHN GLAS. SANDEMAN.

REPLIES.

10. WATER AND ITS OWN LEVEL.—Are not the difficulties of G. G. B. and Mr. A. Mercer referable simply to their neglect to define to themselves the meaning they attach to the expression "its own level"? The latter correspondent's suggestion is that the surface of a small area of water may possibly be *flat*, whereas the truth is that, eliminating all extraneous forces (such as centrifugal force, solar and lunar attraction, winds, and—in minute wet surfaces—globular and capillary attraction), no water-surface, however small, can possibly be flat. In other words it can never be tangential to any spherical surface, but must be itself an actual part of a spherical surface, and of a curvature appropriate to its radial distance from the Earth's centre. Consequently, that which the surface of any body of water—if disturbed—does again seek is "its appropriate spherical curvature"; and if the word "level" be assumed necessarily to mean a *plane* surface then the whole expression "Water finds its own level" must be considered not only unscientific but directly untrue.

If the above statement of theory be accepted the following occur to me as some of the more curious of the necessary results:—

If the rotation and revolution of the Earth were suddenly stopped (again we must eliminate external gravitational forces, as also the moment of inertia), the equatorial oceans would immediately flow away northwards and southwards, in an attempt to reduce the spheroidal wet surface of our globe to that of a true sphere.

Again, under existing circumstances, the surface of the Dead Sea is no less than one thousand two hundred and ninety-two feet below that of the neighbouring Mediterranean. Consequently, being part of a sphere of lesser radius, any circular acre (say) of the former sea will have a wholly different surface-curvature from that of a circular acre of the Mediterranean, and—sequentially—a lesser right horizontal diameter.

Much more markedly will a given area of ocean in equatorial regions differ from the same in polar regions.

More strikingly still follows this fact, that any particular portion of the ocean-surface must have different curvatures, even at high-water and low-water respectively; and consequently that the tables for calculating horizon-dip and distance given in such books as "Chambers' Tables" and "Molesworth's Formulae" can only be averages or approximations, since they can only strictly be true for one latitude or one state of the tide.

Lastly, one has, of course, to admit that the surface of a stationary cup of tea varies momentarily, owing to the lunar and solar tides caused in it. But what seems to me to require, perhaps, even a larger degree of imagination, is to realize that the surface of the liquid must undergo a continuous alteration of curvature even as one raises the cup from the table to one's lips.

W. E. YERWARD-JAMES.

13. THE FINDING OF THE TIME AT NIGHT.—To find the time at night without instruments or notes of any kind, it is necessary to acquire the faculty of estimating, by eye, the distance in time of any star from the meridian.

The imaginary arc representing the latter can be readily conceived by reference to the Pole Star. Having determined the first-named element the remainder is a simple question of Right Ascensions (R.A.).

Commit to memory R.A. of a very few conspicuous stars and learn to recognise them at sight.

The R.A. of the Sun is still easier, it being only necessary to recollect that it starts from $0^h\ 0^m$ at the vernal equinox, March 22nd, and increases two hours per month till the annual round is complete at twenty-four hours.

Proceed as follows:—
R.A. of star + or − time from meridian = R.A. of latter.
R.A. of meridian + or − R.A. of Sun = time.

Example, January 5th, 1911.
Sirius in S.E. quarter, apparently $3^h\ 30^m$ E. of meridian.

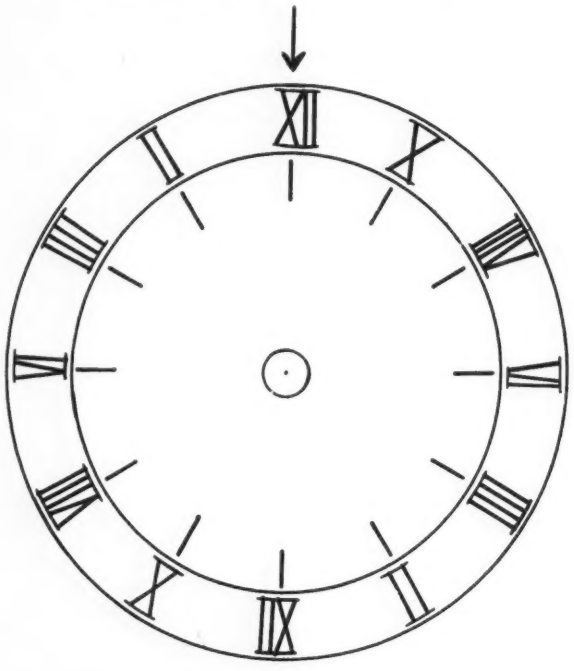
R.A. of Sirius ...	6^h	40^m		
Deduct	3^h	30^m		
R.A. of meridian	3^h	10^m	$+ 24^h =$	$27^h\ 10^m$
R.A. of Sun deduct				$19^h\ 0^m$
Time =				$8^h\ 10^m$ p.m.

EDMUND ROURKE, R.N.

XUM

13. THE FINDING OF THE TIME AT NIGHT.—In the note by R. H. M. B. in the January number, in the diagram of the dial a IV was misprinted for VI, and for the benefit of our readers who may be wishful to use it we insert an amended illustration.

Polaris and β Ursae minoris.					
1 Jan.	1 July	VIII	1 Apr.	1 Oct.	II
1 Feb.	1 Aug.	VI	1 May	1 Nov.	XII
1 Mar.	1 Sept.	IIII	1 Jun.	1 Dec.	X



14. WHICH IS FASTEST—SIGHT OR HEARING?—This question is somewhat indefinite. In any practical case *e.g.*, the sight and sound of an electric spark, the relative velocities of light and sound make it certain that the retina will be affected earlier than the ear drum, but it does not necessarily follow that the consciousness of the light will precede that of the sound, though it will certainly be so if the spark is distant by more than a very few inches. If the question is which can produce the quickest physical response, it is practical and interesting, and can be made the subject of experiment; in this case, the relative intensities of the light and the sound are an important factor, and results with different individuals vary considerably.

J. H. G.

22. RADIUM.—The ratio given on page 49 of Radium to Uranium should read $3{\cdot}8\times10^{-7}$.

25. THE TIDES.—Mr. Hardcastle in a reply to a query of mine has, unavoidably, as I quite see, from the wording of the question, misapprehended my object. The question was suggested by the pages in Darwin's "Tides," pages 240–242, to which he refers me, and I purposely did not mention Darwin or carry the question a stage further on, because I wanted to elicit an independent answer and, if possible, one independent of the mathematical fiction of considering free wave and forced wave motions in a single wave as separate entities. A word about this "fiction" later.

Adopting this fiction, it seems to me that a mental picture of the way in which friction comes in and its direction, is much more easily formed (the free wave tendency being continuously destroyed by the friction) than if the wave form is considered as simply due at each moment to the combined action of lunar force and gravity together. Now I imagine that Darwin deliberately elected to avoid the fiction as possibly liable to produce misconceptions in anyone new to the subject and probably without mathematical knowledge. With the attempt I feel every sympathy, but it creates, I think, more difficulties than it avoids. There seem to me points in his presentment of the subject which to a novice will appear shadowy or even false. Moreover, I am doubtful whether he has really avoided the fiction, and he has made his argument more difficult to follow by unconsciously omitting a step (or half-step; the principle has been explained earlier). At one point a student will almost invariably ask, "How can a change in the depth of the ocean suddenly reverse the action of the friction?" and I think the answer would implicitly involve the use of the tabooed fiction. To take only one point, which point, however, forms the basis of the whole argument, on page 241. "When, as in reality, the liquid is subject to friction, it gets belated in its rhythmical rise and fall, and the protuberance is carried onwards by the rotation of the planet beyond its proper place." Now the reader will very likely argue that friction would cause moving particles to come to rest sooner, and therefore the rise and fall would be accelerated, and the tidal prominence would fall behind instead of in front of the moon, and I certainly think that failure to see further into the matter would not indicate want of intelligence. Perhaps this may seem hypercritical, and it is impossible to define strictly what constitutes a *popular* explanation; in general terms I should define it as one which gave the reader a clear mental picture of what was going on, without suppressing difficulties in the principles applied. With regard to the latter point I need not say about a book so widely known, how singularly free in general it is from this weakness, and perhaps this is the only case (probably the most difficult of those set for explanation), where I should feel inclined to criticise the treatment as not quite satisfactory.

With regard to the "fiction," it is in reality no greater than that of identifying a force with two components into which it may be resolved, and is in fact, under more complex conditions, identical with it; but I certainly think that a student beginning the study of dynamics should be encouraged to regard the kinematical parallelogram law, when applied to dynamical problems, in the light of an hypothesis, to be verified by finding that in every sort of combination it leads to consistent results and is always confirmed by experiment.

J. H. G.

THE ANCESTRY OF DOMESTIC CATTLE.

AT a meeting of the Zoölogical Society of London, held on February 7th, Professor J. Cossar Ewart, F.R.S., gave an account of some skulls of oxen from the Roman station at Newstead, Melrose. The evidence which he had obtained was against the descent of all European cattle from the Urus (*Bos primigenius*) as well as of that of all European, Indian, and African breeds from the Asiatic Urus (*B. nomadicus*). His conclusions are as follows:—

1. That the Celtic Shorthorn (*Bos longifrons*) is probably more intimately related to the Zebu of India (*Bos indicus*) than to the European Urus (*Bos primigenius*).
2. That long premaxillae are usually correlated with an occiput of the *Bos primigenius* type, while short premaxillae are usually correlated with an occiput of the *Bos acutifrons* type.
3. That polled black Galloway cattle and polled white "wild" Cadzow cattle are intimately related to the Urus, that flat-polled Aberdeen-Angus cattle probably include amongst their ancestors an ancient Oriental race now represented by, amongst others, a Syrian breed with rudimentary horns, and that round-polled cattle may belong to a still more ancient Oriental race descended from *Bos acutifrons* of the Punjab Siwaliks.

NOTES.

ASTRONOMY.

By A. C. D. Crommelin, D.Sc.

NOVA LACERTAE.—The visible existence of Nova Lacertae, before its outburst, noted as possible by Mr. Bellamy last month, has now been fully verified. Professor Wolf has measured plates taken in 1904 which give the position (referred to the equinox of 1900) Right Ascension $22^h\ 31^m\ 44^s{\cdot}99$ North Declination, $52^\circ\ 11'\ 55''{\cdot}9$. His plates of the present year give Right Ascension $0^s{\cdot}10$ greater, and Declination $0''{\cdot}1$ greater. Professor Barnard has also identified the object on plates of his, taken in 1893, 1907 and 1909. He has also measured these plates, finding the position practically identical with that of the present year, thus leaving no doubt of the identity of the object, and showing that its proper motion is small, which we expect to be the case with Novae, from the fact that they always appear in or near the Milky Way, and are, therefore, very remote. The magnitude before the outburst was twelve-and-a-half according to Wolf, fourteen according to Barnard. It would not, therefore, be visible on plates taken with a short exposure, which probably explains its absence on the plates taken at Harvard on November 19th last, and on earlier dates. This is, I believe, the first occasion on which a Nova has been certainly identified with a visible pre-existent object; of course, the probability of doing so increases as the storehouse of plates grows larger. But this is not the only reason, for plates of the Nova Persei region were in existence, and failed to reveal any trace of it. It is evident that that outbreak was on a grander scale than the present one, for it sprang up from the fifteenth magnitude (or fainter) to the first, while this has only risen from the fourteenth to the fifth. It will be interesting to see whether it declines to its former magnitude, or remains permanently brighter. Professor Barnard notes a peculiarity which it shares with Nova Geminorum, viz., that it has two distinct and sharp foci, one at the ordinary focus, the other eight millimetres further out, and due to the great brilliance of the crimson H (alpha) line of hydrogen. The Nova has been steadily declining since the outburst; its light fell off during December from the fifth to the seventh magnitude, and by the end of January it was about eight-and-a-half. Its circumpolar position will enable it to be continuously kept in view during the decline of its light.

THE SPECTRUM OF MARS.—Astronomers will remember Professor Campbell's expedition to the top of Mount Whitney, in the endeavour to obtain evidence of the presence or otherwise of water-vapour in the atmosphere of Mars. He has now approached the problem in another manner. It is many years since the shift of lines in the solar spectrum due to rotation was used to distinguish solar lines from those that had their origin in our atmosphere. Great dispersion was necessary, owing to the slowness of the sun's rotation. In the case of Mars, an equal dispersion is unattainable, owing to the faintness of the spectrum, but the relative velocity is much higher. Professor Campbell and Dr. Albrecht, took a series of plates with a specially designed grating-spectroscope in January and February, 1910, using plates rendered sensitive to the red-end, where the water-vapour band is situated. After careful examination of the plates they state that the amount of water-vapour in the planet's atmosphere on February 2nd, 1910, was certainly less than one-fifth of that in the air above Mount Hamilton at the time. The amount of oxygen in Mars' atmosphere was also relatively small. These results are only what we should expect, for it is obvious, both from the planet's small mass, and from the great distinctness with which the markings are seen, that its atmosphere is very much rarer than our own. Those who deny the existence of water-vapour in its atmosphere are driven to adopt the conclusion that the polar caps, and the occasional presence of cloud and mist, are due to some other substance, such as carbon dioxide.

HALLEY'S COMET is still under observation, and is being assiduously followed by Professor Barnard with the forty-inch Yerkes' Refractor. It is now of the fourteenth magnitude, round, $32''$ in diameter, slightly condensed, but without a visible nucleus. It is considerably further from the Sun than when first photographed in August, 1909, and yet is two magnitudes brighter, showing that the physical brightening at perihelion persists for some time. Professor Barnard has hopes of keeping it in view till the end of the year; it will then be far outside the orbit of Jupiter, which it will cross in April next. It will remain invisible for seventy-four years, and will probably be detected in August, 1985, passing perihelion about February, 1986.

D'ARREST'S COMET was still in view at the end of January, being seen by M. Gonnessiat at Algiers on January 22nd, when it was of magnitude fourteen-and-a-half. The Paris Observatory has recently lost by death M. G. Leveau, whose name is especially associated with this comet, from the laborious care with which he has followed its movements ever since 1864; the large perturbations by Jupiter render the work difficult, but nevertheless his predictions have been extremely exact, extending even down to the present return. He also constructed tables of the minor planet Vesta, by which its motion can be calculated with greater convenience and accuracy than by the method formerly employed.

BOTANY.

By Professor F. Cavers, D.Sc., F.L.S.

IRON BACTERIA.—Molisch has recently published one of his excellent monographs (*Fischer, Jena*; M. 5), the latest production of his prolific pen being an important summary of his own work, continued for eighteen years, as well as that of other investigators, on this interesting group of bacteria. Since the iron bacteria are of practical as well as scientific interest, this monograph ought to be translated into English, in order to attract wider attention among workers in hydraulic and sanitary engineering, as well as in biological science. To the six already-known species of iron bacteria, Molisch adds three more, of which one grows in the stems and leaves of aquatic plants. He finds that these bacteria can grow quite well in absence of iron, and that they can make use of manganese instead of iron. The iron dissolved in the water is, according to Molisch, merely deposited in the slimy sheaths of the bacterial filaments in the form of carbonate of iron, which becomes oxidised to ferric oxide, and this is apparently not used by the bacteria in their vital processes but simply acts as a protection to the protoplasm—in much the same way as the silica deposits in diatoms and the epidermal cells of grasses, and so on.

The iron bacteria occur in most bogs, chalybeate springs, stagnant waters, and sometimes in iron water-pipes—in the latter case often plugging up the pipes, besides fouling the water itself; so far, no species have been found in sea-water. These bacteria may be removed by filtration through sand or coke, or by chemical treatment, and in either case Molisch finds that the real cause of the disappearance of the bacteria is the loss of soluble organic substances which are removed by these processes, the absence of the iron itself being a matter of indifference. Various other organisms—certain Algae, Flagellates, and Infusoria—are capable of fixing iron; some of these can also fix manganese, and their mode of action appears to be the same as that of the iron bacteria. Molisch also discusses the formation of bog iron, in which the iron bacteria often play an important part; the formation of rust in iron water-pipes, which is probably due primarily to the action of the water itself acting on bare iron surfaces, though here again the iron bacteria may flourish if organic substances are present in addition to soluble iron oxide; and the therapeutic use of chalybeate waters, which are often quite useless for medicinal purposes on account of the precipitation of the iron as insoluble ferric hydroxide.

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NITROGENOUS SALTS IN SEA-WATER.—Gebbing (*Internat. Revue d. ges. Hydrobiol. und Hydrogr.*, 1910) has collected the results of the German South Polar Expedition with reference to the nitrogen-content of sea-water, comparing these results with others previously obtained. Although chemical in character, Gebbing's paper is of great interest in connection with the distribution and periodicity of the plankton or surface-living vegetation of the sea. The chief results are the following. The content of the ocean in ammonium salts is fairly constant, the average value being 0·05 milligrams per litre. The distribution of the nitrates and nitrites is, however, very variable, the highest proportion of these salts in the surface water being found in the Antarctic Ocean, while it dwindles towards the Equator from 0·5 milligrams to 0·1 milligrams per litre. In the North Atlantic and in the North Sea there is marked poverty in these salts, as compared with the Southern Hemisphere, there being practically no increase on passing northwards from the Equator. The scanty plankton of tropical seas is probably due to the fact that the higher temperature favours the growth of denitrifying bacteria, which attack nitrates and nitrites, setting free nitrogen. At the Equator, also, there is a much more rapid falling-off in nitrogen-content in passing below the surface, and this may obviously be attributed to the greater vertical circulation of the water in the Tropics. Gebbing's interesting memoir is an important contribution to biology as well as to chemistry and oceanography, and helps in clearing up various problems in the distribution of the floating vegetable population of the sea, which is largely used as food by the animal plankton as well as by the larger denizens of the ocean.

CYCAD ROOT-TUBERCLES.—The remarkable coralloid roots of Cycas have long been known to harbour colonies of the Blue-green Alga *Nostoc* or *Anabaena*, which usually form a definite layer in the cortex of these roots. In addition to the *Nostoc*, bacteria occur in these roots, evidently causing the formation of the tubercles and living in symbiosis with the Alga. An interesting paper on this symbiosis was read by Professor Bottomley at the Sheffield Meeting of the British Association (see Botany Notes in "KNOWLEDGE," October, 1910); the presence of the bacteria was noted by Schneider in 1894 (*Bot. Gaz.*). Now, Zach (*Oesterr. Bot. Zeitschr.*, 1910) has found that in addition to the *Nostoc* and the bacteria, these Cycad roots contain a fungus which attacks the cortex cells and causes degeneration of the nuclei, loss of starch and production of calcium oxalate in the infected cells. No fungus filaments occur, however, in the *Nostoc* zone, and Zach found that the fungus has nothing to do with the causation of the tubers, but lives in the roots simply as parasite.

RECENT WORK ON THE LOWER FUNGI.—Among many interesting papers on the lower Fungi, there are some which serve to link up the Yeasts to the more typical lower Ascomycetes. The Yeasts have long been regarded as degenerate Ascomycetes, their peculiar features—such as the budding process of multiplication and the general absence of sexual fusion—being correlated with their mode of life in sugar solutions, which they decompose with the formation of alcohol and carbon dioxide. The work of Hansen and others has shown that not all Yeast species cause alcoholic fermentation, and that some species produce a definite, though simple, mycelium or filamentous plant-body, while the spores of some species have a peculiar hemispherical or hat-like form, which agrees exactly with the shape of the spores in *Endomyces*. Barker's interesting discovery of the conjugating Yeasts, in which the cells fuse in pairs before producing spores, may be regarded as an indication of a simple sexual process similar to that observed in such simple Ascomycetes as *Eremascus* and *Gymnoascus*.

Guilliermond (*Rev. gén. Bot.*, 1909) has investigated the following forms of lower Ascomycetes:—*Eremascus*, *Endomyces*, *Saccharomycopsis*. In *Eremascus* the cells of the mycelium are at first multinucleate, but later become uninucleate, and the asci arise in most cases from two fused cells, but sometimes without fusion (parthenogenesis). In fusion, a nucleus from each of the two cells migrates into the young ascus, the two nuclei fuse, and the fusion-nucleus divides until the eight spore-nuclei are formed. In *Endomyces fibuliger* the mycelium, when in sugary liquids, forms buds exactly like those of Yeast, and multiplies rapidly in this way. In a paper which appeared simultaneously with that of Guilliermond, Dombrowski (*Comptes rendus du lab. de Carlsberg*, 1909) showed that these Yeast-like cells of *E. fibuliger* can produce conidia, differing from the sprouting Yeast-like cells themselves in being able to resist heating to 55° C., a temperature which destroys the budding cells. Guilliermond found that, as a rule, the asci arise singly as branches from the ordinary mycelium, showing no trace of a fertilisation process, and producing only four spores. In some cases, however, anastomoses occur between the ascus mother-cell and the neighbouring mycelium cell, or between an ascus mother-cell and a Yeast-like cell, and this he thinks points to degeneration of a former fertilisation. In *Endomyces magnusii* the asci may either arise parthenogenetically, or after conjugation of two mycelial branches differing in size, four spores being formed; in this species no Yeast-like budding occurs, though resting cells are formed. In *Saccharomycopsis*, there is no trace of fertilisation: the ascus contains four spores; according to the culture conditions the plant produces either a mycelium or Yeast-like cells, and the genus is closely related to *Endomyces*, being distinguished from the Yeasts (*Saccharomycetes*) by the double wall of the spore. Guilliermond concludes with a discussion of the systematic arrangement and inter-relationships of the lower Ascomycetes, pointing out that in *Eremascus* the only method of reproduction is the formation of an ascus from two fused cells, while in *Endomyces* the asci may be formed either by fertilisation or by parthenogenes, is and in addition to ascospores the plant reproduces itself by Yeast-like budding and by conidia. The genus *Endomyces* forms a transition from *Eremascus* to the Yeasts, a form like *E. fibuliger* connecting *Eremascus* to the ordinary Yeasts (*Saccharomyces*) and the Conjugating Yeast (*Zygosaccharomyces*), while *E. magnusii* leads to the Splitting Yeast (*Schizosaccharomyces*).

Guilliermond's important results are confirmed by a paper by Lewis (*Maine Agric. Exp. Sta.*, Bulletin 178) on a new species of *Endomyces* discovered by him on decaying apples. In this fungus—*Endomyces mali*—the asci arise by parthenogenesis on short lateral branches of the mycelium and produce four spores, while conidia are also produced, but no Yeast-like budding occurs and the Fungus cannot ferment sugar, though *Endomyces magnusii* can do this.

Westling (*Svensk bot. Tidskr.*, 1909) has described a new genus, *Byssochlamys*, which he regards as forming a connecting link between *Endomyces* and *Gymnoascus*. This Fungus was found on plants that had been preserved in alcohol, and it could not only exist but actually flourish in strong alcohol (90%), which kills even the spores of most other Fungi! This new Fungus proved even more long-suffering under adverse conditions than the ubiquitous and highly-resistant Blue Mould (*Penicillium*), and grew well at 37° C., ousting *Penicillium* from a culture heated to this temperature. *Byssochlamys* reproduces itself by means of ascospores, conidia, and thick-walled resting cells (chlamydospores); the asci have eight spores and arise laterally from a spirally coiled ascogonium, which is usually fertilised by a male filament (antheridium) but is sometimes parthenogenetic.

HELIOTROPISM.—Some of the more recent work on heliotropism was summarised in these columns a short time ago. An interesting paper by Figdor (*Ann. jard. bot. Buitenzorg*) shows that not only do foliage leaves perceive the stimulus of one-sided light but that this stimulus is transmitted backwards to the stem. Figdor experimented with the leaves of *Begonia*, arranging his apparatus so that only the leaf-blade was exposed to the light, and found that not only the leaf-stalk but the stem below the leaf showed strong curvature towards the light. Figdor had previously shown, also in experiments with *Begonia*, that the stem itself can perceive and respond by curvature to the stimulus of light falling upon it from one side, but his recent result is of great importance in showing that in Dicotyledons, as well as in

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Monocotyledons (*e.g.* grass seedlings), the stimulus can be transmitted from the receptive surface of the leaf to the lower parts of the plant.

MALE NUCLEI IN FLOWERING PLANTS.—Some years ago, Nawaschin observed that when the pollen-tube of an Angiosperm—he worked with *Lilium martagon* and *Fritillaria tenella*—reaches the embryo-sac, both of the male or generative nuclei enter the sac, one fusing with the egg and the other with the central nucleus (variously called the "secondary" or "definitive" or "fused polar" nucleus), the embryo arising as the result of the former fusion, and the endosperm as the result of the latter. This remarkable discovery, which was made almost simultaneously by Guignard, and has since then been confirmed in a large number of Monocotyledons and Dicotyledons from the lowest to the highest families, also led to the observation that the male nuclei are elongated and worm-like, or even spirally coiled, like the body of the motile male cells of lower plants, and Nawaschin suggested that these nuclei might have the power of independent locomotion. Most later writers have rejected this view and considered that these nuclei are carried along passively by streaming of the protoplasm in the embryo-sac, but Nawaschin has recently (*Oesterr. bot. Zeitschr.*, 1909; *Ann. jard. bot. Buitenzorg*, 1910) obtained evidence, almost amounting to positive proof, that the two sperms actually move towards the two nuclei with which they fuse, and that when spirally coiled like a cork-screw they rotate during their passage through the embryo-sac, and thus burrow through the protoplasm on their way to the egg and the polar nuclei.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

TETRODON POISON.—Various species of *Tetrodonae* are common in the seas of Japan, and are extensively used as food, after removal of the ovaries, in which is secreted the characteristic poison of the fish. This toxic substance, which is not present in the flesh, has been investigated by Mr. V. Tahara (*Biochem. Zeits.*, 1910, xxx, 255), who isolated it by grinding up the ovaries of the fish with water, concentrating the liquid, and precipitating albuminous substances and phosphates. On now adding ammonia to the filtrate the poison was precipitated in an impure condition, and was subsequently purified by repeated treatment with lead acetate and ammonia, and extraction with alcohol, in which it was partially soluble. As thus purified tetrodon poison was a white powder, which absorbed moisture on exposure to the air. It was nearly insoluble in most organic solvents, and was only sparingly soluble in water. Its reaction was neutral, and it is therefore suggested that it should be termed *tetrodotoxine*, instead of *tetrodonic acid*, as heretofore. Apparently it was neither an alkaloid nor a protein, but formed precipitates with the hydroxides of heavy metals, and on treatment with dilute hydrochloric acid was decomposed, with the formation of a basic substance and a crystalline body containing no nitrogen. The preliminary analyses indicated that tetrodotoxine had a composition agreeing with the formula $C_{16}H_{31}NO_{16}$, and this is provisionally assigned to it. Physiological experiments proved that the toxine was very active.

FILAMENTS FOR ELECTRIC LAMPS.—The modern methods of preparing the filaments for incandescent electric lamps are particularly ingenious, and illustrate the ways in which chemical processes may be used to overcome apparently insuperable difficulties. The carbon filaments are now almost universally made by a method similar to that used in the manufacture of artificial silk. A solution of nitrocellulose (collodion cotton) in acetic acid is rapidly pressed through a small opening, and the resulting filaments are twisted into the required shape round carbon blocks, which are placed in boxes of fire-proof clay and heated in a furnace until the filaments are carbonized. They are then heated, by means of an electric current, in an atmosphere of benzine, so as to remove the last traces of volatile substances. It is essential that the carbonised filament should be homogeneous throughout, and that, as far as possible, it should have been converted into the graphic form of carbon, which is not decomposed so rapidly by the current, and thus retards blackening of the glass.

The amount of electricity consumed by carbon lamps has led to the extensive use of lamps containing metallic filaments, and an interesting survey of the different processes that are being used for the production of these is given by Mr. H. Baumhauer in the *Zeit. angew. Chem.* (1910, xxiii., 2065). The only metal of sufficiently high melting-point that has been found suitable for the direct production of filaments from the pure metal is tantalum, and tantalum lamps have now been sold for some years.

It was shown by Weiss (*Zeit. anorg. Chem.*, 1909, lxv., 288) that titanium and zirconium melted at too low temperatures to be available for the purpose, while he was unable to melt tungsten, the estimated melting-point of which is 2800°C. Owing to this, it has not been found possible to prepare filaments of tungsten directly from the metal, but the problem has been solved in other ways. Thus, in one type of lamp no longer on the market, tungsten filaments were prepared by coating carbon filaments with a deposit of sublimed tungsten chloride, and then heating them in a current of hydrogen to reduce the tungsten compound to the metallic form, and expel the carbon. Owing to the low resistance offered by the filaments this process was abandoned, and at the present time tungsten filaments are made by mixing tungsten oxide with an excess of zinc dust and heating the mixture in a loosely-covered iron vessel until the reaction takes place. The zinc is then dissolved from the mass by means of hydrochloric acid, and the reduced metallic tungsten is left in the form of a black powder. This is made into a paste with caramel or gum tragacanth, and is forced through minute openings, so as to form filaments, which may be dried and heated in a current of hydrogen to expel the carbonaceous agglutinating material.

A still more recent method of manufacturing tungsten filaments is by means of a colloidal solution of tungsten obtained by alternately treating the metal with acid and alkaline reagents, so as to obtain a flocculent gelatinous mass. This is separated from water by squeezing it in silk, and is then ready to be made into filaments without the necessity of adding any binding substance. This process is used in the manufacture of the "Sirius" and "Colloid" lamps, while in the case of other tungsten lamps a binding material is also employed.

Attempts to use other metals of high melting-point, such as osmium and zirconium, have not proved nearly so successful as the methods in which tungsten is used alone, and processes of adding metals to the carbon filaments in the ordinary lamps have also proved unsatisfactory. Thus, according to Mr. Baumhauer, a lamp recently put upon the market contained carbon filaments coated with zirconium, but although at first there was greater emission of light and smaller consumption of electricity, the life of the filament was considerably shortened, and the consumption of electricity soon rose to that of an ordinary carbon lamp.

GEOLOGY.

By RUSSELL F. GWINNELL, B.Sc., A.R.C.S., F.G.S.

THE ORIGIN AND PEOPLING OF THE DEEP SEA.—Under this title a translation of a paper by Professor Johannes Walther appears in the *American Journal of Science* for January. Comparing land and water, Dr. Walther points out that while temperature decreases with height and depth respectively, in the ocean great depths, and hence low temperatures, preponderate. Half the Earth's surface is deep sea, with an average depth of four thousand metres and a maximum of from eight to ten kilometres. The inhabitants of this great area are considered with especial reference to the light which they throw on the origin of the deep sea. The characteristics of abyssal depths are:—(1) a uniformly low temperature; (2) quiet water, with no noticeable movement; (3) no light, and as a consequence no green-plant life. Hence all light-hungry and plant-eating animals, and all which need moving and warm water, are absent; nevertheless, life is

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abundant in the abysses. Where sunlight and green plants are wanting no organic life can be maintained; the fauna of the deep sea is dependent upon the stream of cold south polar water pouring oxygen and food into its abyssal depths. *The origin of this fauna must, then, be sought in sunlit areas rich in plants.* When did the peopling of the abysses take place? The significant fact appears that no single Palaeozoic animal is found in the present deep sea, although a number of shallow-sea and other genera survive from the Palaeozoic Era (*e.g.* Lingula, Mytilus, Pleurotomaria, Nautilus, Serpula, Astropecten, the littoral Limulus and the fluviatile Ceratodus, besides soft-bodied animals which could not be preserved fossil). Animals now living below two thousand metres date only from the Trias, the resemblance to Jurassic and Cretaceous faunas being particularly close; among the Echinoderms, for example, are found Pentacrinus, Asterias, Echinus, etc. Evidently, then, *the peopling of the deep sea is traceable, at the earliest, to the Triassic Period.*

Now we know that the elevation of mountain-chains is counterbalanced by the formation of extensive depressions; also that at no other period did such enormous mountain folding occur as took place between Carboniferous and Triassic times, when the Hercynian movements in Europe occurred, the Appalachians were formed in America, the Sudanese mountains were originated in Africa, and other folding took place in Asia and elsewhere. *In the deep ocean abysses Dr. Walther sees the complementary depressions to these mountain chains.*

Thus general biological grounds, the stratigraphical position of the present deep sea fauna, as well as tectonic investigation, force us to the conclusion that the deep sea as a life-region is not a characteristic of the Earth in its oldest periods, and that its origin is found in the time when in all parts of the present continents began tectonic folding movements which so decidedly changed the relief of the Earth's surface.

THE GREAT NEW ZEALAND ERUPTION.—In the January number of the *Geographical Journal* Professor James Park describes the volcanic outburst of Mount Tarawera, which took place in 1886, and which utterly destroyed the celebrated pink and white terraces of Rotomahana. The subsequent changes due to waning vulcanicity and to denudation are also dealt with. Mount Tarawera—three thousand six hundred feet high—rises abruptly from the lofty rhyolitic plateau of Rotomahana, in the North Island of New Zealand. During a space of about three hours the mountain was gradually rent across from north to south by a great fissure, nearly nine miles long, averaging two hundred yards wide and from one hundred to three hundred yards deep. The vulcanism was of a rare or new type; for whereas fissure eruptions are distinguished by quiet emission of lava-floods, in this case the ejecta were almost entirely fragmental, consisting of dust, lapilli, bombs, and so on, derived from an augite-andesite magma, intermixed with some rhyolitic ash. These materials were spread over an area of nearly six thousand square miles, in a sheet varying up to fifty feet in thickness, and dust fell on vessels one hundred and fifty miles away. This great ash sheet has since become covered with dense jungle, and has been deeply scored by rain into narrow gutters and ridges. The sections thus exposed are seen to consist of grey dust and black ash, so well stratified as to be easily mistaken for a subaqueous tuff.

During the course of the fissuring Lake Rotomahana was encountered, and as a result a shattering explosion converted the lake-bed into an active volcano over a mile in width. A native village on its shores was simply blown out of existence, all the inhabitants being instantly killed. Several other villages were overwhelmed with dust, not a soul surviving. For a few months violent hydrothermal activity was displayed, a pillar of steam rising to over fifteen thousand feet; it then waned and ceased, and the lake-bed filled up again with water. About 1897, geysirs again began to play and the world-famed Waimangu geysir was in action until two or three years ago. Though this has now ceased, solfataric action is still very conspicuous on the lake-shores. At Echo crater the formation of iron pyrites can now be seen in progress; the crater-floor is covered with a thin siliceous crust, through which boiling water and steam escape. Interaction takes place between the hot ascending mineralised waters, and the H_2S with which the steam is charged, and as a result FeS_2 is deposited, first as a black and then a bright yellow film on all the loose stones lying around.

Though of an abnormal type, the 1886 eruption was merely one of a long succession of volcanic phenomena which have been in progress since Pliocene times along the great tectonic fracture known as the Whakatane fault—along which are situated many other volcanoes, active, dormant and extinct.

GEOTECTONIC SYMMETRY.—Last November there appeared in these columns a note dealing with the "Canadian Shield," a great mass of gneiss and schist forming one of the "corner stones" of the earth. In the *American Journal of Science* for December R. Ruedeman points out the strikingly symmetrical arrangement of the large area of Palaeozoic rocks, which extends southwards from this Canadian "protaxis," or shield of pre-Palaeozoic rocks. This area, the "Palaeozoic Platform" of North America, is roughly bounded on the west by a line connecting the head of Lake Superior with the Ozarks, and on the east by a line enclosing the Adirondacks and Appalachians. It corresponds in its relation to the Canadian shield with that of the Russian platform to the Baltic shield. It is bounded on the west by the transcontinental depression occupied by Cretaceous and Tertiary rocks.

On either side of the Canadian shield there stand out, like a corner-stone, a pre-Cambrian area ("Isle Wisconsin" and "Isle Adirondack"), in quite symmetrical positions. From each of these extensions there runs outward, along the margin of the shield, a deep depression, the Lake Superior basin and the St. Lawrence basin, respectively. From these same corner-stones there extend southwards a pair of arms, as it were, each consisting of a broad belt of pre-Cambrian and early Palaeozoic rocks, nearly the full length of the Continent. In both cases this elevated tract of old rocks terminates to the south in a pre-Cambrian mass, and these two masses—"Isle Ozark," on the west, and "Isle Appalachia," on the east—are symmetrically situated.

Thus is enclosed a great median basin (that of the Great Lakes and Ohio) which is itself symmetrically sub-divided by the Cincinnati geanticline. This broad anticline, striking north and south, separates two sub-basins of younger Palaeozoic strata, situated in symmetrical east and west positions: it dies away to the north, being replaced by the Michigan basin. In this basin we may, perhaps, see a result of a longitudinal oscillation of the axis of the Cincinnati geanticline, for it also lies symmetrically to the whole arrangement, constituting, with the Cincinnati uplift, the axis of symmetry of the whole "Palaeozoic Platform."

One serious disturbance of symmetry has occurred, due to Atlantic pressure exerted from the south-east; this has pushed the eastern arm inwards, thus giving rise to the Appalachian basin-folds. Even here, however, the belt of old rocks is recognizable, running south and south-west from New York as far as Alabama.

METEOROLOGY.

By JOHN A. CURTIS, F.R.MET.SOC.

THE weather of the week ended January 21st was, generally speaking, dry but dull, with a good deal of fog. Temperature was above the average in Scotland and in Ireland N., but below it elsewhere. The highest readings were 53° at Killarney and Scilly on the 16th, while the lowest readings were 21° at Swarraton on the 15th, and at Durham on the 21st. In Scotland N. and the English Channel, the lowest readings were 33°, but in all the other districts frost was recorded, from 28° downwards. The lowest readings on the grass were 15° at Crathes and Llangammarch Wells, and 16° at Durham and Kew. Rainfall was deficient in all parts and in most districts markedly so; at many stations no rain was reported during the week. In Scotland N., however, there were stations where rain fell each day, though not to excess,

The amount of bright sunshine did not vary much from the average except in Scotland E. and England N.E., where it was nearly twice as much as usual. Crathes reported 27·1 hours or 54 per cent. At Westminster the duration was only 0·2 hours for the week. The temperature of the sea-water varied from 38° at Cromarty to 48° at Plymouth and Seilby.

The week ended January 28th was warm, and at each of the stations included in the Weekly Weather Report the mean was in excess of the average. Maxima of 50° or upwards were reported from all districts, the highest being 59° at Killarney on the 25th. The lowest of the minima were 25° at Shields and 26° at Kilkenny and Hereford. On the grass readings down to 20° at Tunbridge Wells and 21° at Dublin (Trinity College) were reported. Rainfall was scanty in most districts, very much so in some. In the Midlands the total (district) fall was only 0·04 inch, as compared with an average of 0·50 inch. At several stations the week was rainless. In Scotland the fall was heavier, though still below the average. Bright sunshine was also below the average, except in Ireland S. and England S.E. In Scotland E. the deficiency was large, and in this district the highest amount at any station was only 3·8 hours (7%) at Nairn. The sunniest station was Dublin, with 18·7 hours (32%). At Westminster the amount was 5·3 hours (9%). The sea temperature round our coasts ranged from 36° at Cromarty, to 49° at Scilly.

FIGURE 1.
A single Rotifer, feeding.

The week ended February 4th contrasted strongly with that which had preceded it, being much colder and with much more sunshine. Except in Scotland N., the temperature was below the average in all districts, and in England S.E. the mean value was only 34°·7, as compared with 41°·4 in the previous week. The highest reading reported during the week was 51° at Colmonell, Killarney and Valencia. In the Midlands and England N.W., the maximum did not exceed 46°. The minima fell to 11° at Balmoral and to 13° at Llangammarch Wells, while the thermometer, exposed on the grass registered as low as 1° at Llangammarch and 6° at Birmingham. Rainfall was scanty; indeed over a large part of the Kingdom the week was rainless, but sunshine was abundant for the time of year, and was in excess of the average in all districts. The highest amounts for the week were 35·6 hours (57%) recorded at Hastings, and 35·4 hours (55%) at St. Heliers, Jersey. At Westminster the total duration was 12·2 hours (20%). The temperature of the sea-water it may be added ranged from 36° at Eastbourne to 48° at Scilly.

FIGURE 2.
A cluster of Antarctic Red Rotifers.
(Philodina gregaria.)

The week ended February 11th was cool, cloudy and very dry. Temperature was slightly above the average in Scotland N., but below it in all other districts. The highest reading was 53° at Killarney on the 11th, but as a rule the maxima were below 50°; in England N.E. and E. the highest was only 45°. The lowest reading was 11° at Balmoral, also on the 11th. At quite a number of stations the maximum and the minimum were both recorded on the same day. The lowest reading recorded on the grass was 8° at Balmoral. Rainfall was below the average everywhere, and in the English Channel less than one-twentieth of the normal amount was reported. Even in Scotland N. the total collected was only one-sixth of the average. Sunshine was deficient generally, though in Scotland N. and in Ireland it was slightly in excess. Valencia, in Co. Kerry, reported the largest amount, 21·0 hours (33%) and Deerness, in Orkney, had the next highest amount with 18·6 hours (32%). Westminster reported 5·9 hours (9%). The sea temperature varied from 36° at Cromarty to 47° at Scilly.

INVESTIGATION OF THE UPPER AIR.—On January 17th, a balloon from Pyrton Hill reached an altitude of fifteen thousand metres, at which height the temperature registered was 210° absolute scale. At thirteen thousand metres, however, the temperature was only 202° absolute, or −96° F., which is the lowest temperature recorded in the British Isles up to the present time.

The record of a kite ascent at Pyrton Hill, on January 26th, showed a sharp inversion of temperature at a height of nine hundred metres, and while at five hundred metres the humidity was 100 per cent. (saturation), at a thousand metres it was only 30 per cent. The cloud level was not reached on this day at a thousand metres.

MICROSCOPY.

By A. W. SHEPPARD, F.R.M.S.,

with the assistance of the following microscopists:—

ARTHUR C. BANFIELD; JAMES BURTON; THE REV. E. W. BOWELL, M.A.; CHARLES H. CAFFYN; ARTHUR EARLAND, F.R.M.S.; RICHARD T. LEWIS, F.R.M.S.; CHAS. F. ROUSSELET, F.R.M.S.; D. J. SCOURFIELD, F.Z.S., F.R.M.S.; C. D. SOAR, F.R.M.S.

RED-SNOW.—Red-Snow, Gory-Dew, Bloody-Rain, and such-like names show that phenomena of this class appeal to the popular imagination. When some rapidly-increasing organism suddenly produces a blood-red pool on the ground, the simple-minded observer may readily suppose that it has come down as rain, and in superstitious countries and times there is fine scope for connecting the appearance with tragic or momentous events, the vengeance of heaven, and what not.

Even the scientific naturalist feels his imagination excited as he reads of Sir John Ross's "Crimson Cliffs" extending for miles.

De Saussure is commonly credited with the discovery of red-snow, in the course of his pioneer journeyings among the Alps, in the eighteenth century, but according to Schmarda (1846) the phenomenon was known to the ancients, and is mentioned by Aristotle (Hist. Animal. v., 12). In the nineteenth century there were numerous records of red-snow, and there is now quite an extensive literature of the subject. Ross appears to have been the first to find red-snow in the Polar regions, and he brought samples of it from the Crimson Cliffs of Greenland.

De Candolle (1824) compared the Arctic and Alpine red-snows, and declared them to be identical.

Red-snow has been found all over the world in suitable localities, but it does not appear to be of general occurrence in snowy regions. Darwin saw it in the Cordillera, but Hooker never saw it, either on his Antarctic voyage or in the Himalayas. Friends whom I have asked about it saw none on the snowy mountains of Norway and Switzerland. According to some accounts it appears to be most plentiful in the North Polar region, where it is reported from Spitsbergen, Scandinavia, Siberia, and so on. It is recorded also for the Alps, Pyrenees, Carpathians and Ural Mountains, the Sierra Nevada in California, Chili and Ecuador, in South America, and so on.

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In the Antarctic, red-snow appears to be less common than in the North Polar region. The Shackleton Expedition did not find any for certain, but some members saw snow discoloured with what they supposed to be a red Rotifer common there. Bruce's Expedition found a little of it, but the only record I know is in Charcot's preliminary report of his last Expedition (1910). The naturalist of that expedition, M. Gain, informs me in a letter that they found both red and green snow, the former in considerable quantity, the latter forming extensive meadows ("prairies").

What is red-snow? As to the colour of it, is it so very bright? Perhaps we who have not seen it expect too much! Some describe it as blood-red or crimson; others say it is a dull purple; Darwin noticed the footprints of his mules stained a pale red, and the snow was only coloured where it had thawed rapidly or had been crushed. Sir Philip Brocklehurst, who saw our only supposed red-snow, tells me *it* was a very dingy yellow.

Red-snow has been almost universally attributed to a supposed Alga, best known as *Protococcus nivalis*, though it has borne many names, and is now officially recognized as *Sphaerella nivalis*. It is described as consisting of spherical cells, about a one-thousandth part of an inch in diameter, with a thickish cell-wall, and the protoplasmic contents

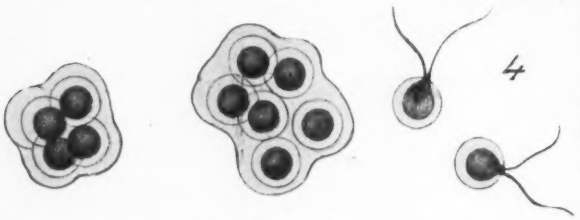

FIGURE 3.
Sphaerella nivalis, two clusters and two free swimming cells, the latter are marked 4.

permeated with chlorophyll, which is, however, completely masked by the red pigment haematochrome. In the growing season the cells enlarge and divide, usually into four daughter-cells, which then separate, take an oval form, and swim about by means of two flagella, which are extensions of the protoplasm projected through the envelope.

It has been so little suspected that any organism but *Protococcus nivalis* could produce red-snow, that one may suppose it has sometimes been recorded as that species, without careful examination. Such was the view of Vogt, who accompanied Agassiz on his Alpine journeys.

Shuttleworth, in 1839, first suggested that other species might participate in making the red-snow.

Vogt (1840) made the remarkable discovery that his samples of red-snow contained a Bdelloid rotifer in abundance. He found associated with the rotifer some smooth and some warted globules, which he satisfied himself were its eggs, and he rather hurriedly concludes that there is probably no *Protococcus nivalis* in existence, the name having been given to rotifer eggs! Those globules of Vogt's are unlike any known eggs of Bdelloids, and I am sure he was wrong about them.

Vogt is not the only authority for the presence of rotifers in red-snow. Lagerheim, in 1892, found a Bdelloid in red-snow in Ecuador. He identified it as related to *Philodina roseola*, which is the same species as Vogt supposed his animal to be.

Now, although the Shackleton Expedition found no indubitable red-snow, we found abundance of red rotifers, which increased with prodigious rapidity and formed conspicuous blood-red stains on stones at the margins of lakes. I named it *Philodina gregaria*.

Vogt gives a very good figure of his supposed *Philodina roseola*, and the spurs are of such a form that Ehrenberg doubted the identification. These spurs are very similar to those of *P. gregaria*. The similar habitat gives colour to the suggestion that they are identical. The Alpine rotifer, living on the surface of snow, must become active at just about the melting-point temperature,—*P. gregaria* lives frozen in ice for years, and resumes activity whenever the ice melts.

It is now admitted that, while *Sphaerella nivalis* may be the commonest cause of red-snow, animals of various kinds may take part in producing the phenomenon. M. Gain, of the Charcot Expedition, makes the latest addition to the list, as he tells me he found reddish mites fairly plentiful in the Antarctic red-snow. There is probably a considerable fauna of red-snow.

What is the significance of the red colour of so many animals which live on the surface of snow? Has it a physiological function in relation to light, enabling the animal to absorb the rays, which will just make life possible in that inhospitable situation? It is noticeable that the red colour of the rotifers, both Alpine and Polar, is confined to the stomach.

There is a tendency, even in science, to reason from insufficient data to erroneous conclusions—"jumping to a conclusion," as it is termed in unscientific language. Let us take warning from some of the facts connected with red-snow. Vogt affords us an example of the danger, in his observations on the supposed eggs of the rotifer of red-snow. He watched till he observed a rotifer "deposit" one of the globules. If this were sufficient evidence, we could soon find such marvellous instances of alternation of generations as would rival the fabled origin of the Barnacle Goose. Had Vogt begun at the other end and waited for an egg to hatch, he would, perhaps, have reached another conclusion.

Red organisms are common enough apart from red-snow, and there is no need to assume that all the red organisms found in that situation have their red colour in virtue of the association. Vogt includes among his animals of the red-snow a Water-Bear with two claws, which he refers to as *Arctiscon* and *Macrobiotus*, but the number of claws and the red colour make it pretty certain that it was a larval *Echiniscus*. Ehrenberg got several kinds of *Echiniscus* high up (11,138 feet) on Monte Rosa. It seems a reasonable supposition that the colour of these animals has a special relation to a life among snow, but so far from this being the case, it is the normal colour in this extensive genus, in species living in all sorts of situations. One of the brightest red species inhabits Australia, where red-snow is little likely to occur.

Ehrenberg found on Monte Rosa, along with the *Echinisci*, a bright red rotifer, which he named *Callidina scarlatina*. It was found dried up, like pink dust, and, I believe, scattered over the snow. But *Callidina scarlatina* is not specially addicted to a life on the snow or even on mountain-tops. If Mr. Bryce's identification is right, it is a familiar species among hepatics growing on trees, in shady glens and similar places.

As to *Sphaerella nivalis* itself, the Alga of red-snow, I find upon enquiry that it is a flagellate Infusorian, related to that very energetic plant-animal, the Globe-animalcule, *Volvox*, claimed alike by zoölogists and botanists. If the flagellates are conceded to zoölogy, then all the organisms of the red-snow are animals.

JAMES MURRAY, F.R.S.E., F.Z.S.

MICRO-SLIDES ILLUSTRATING MITOSIS.—Every student of Cytology appreciates the difficulties attending the preparation of slides illustrating the phenomena of nuclear division. We have received from Mr. C. Baker, 244, High Holborn, a sample slide showing mitosis in all phases, as exhibited in the growing point of the root of *Lilium*. His list of slides also includes the root-tip of hyacinth and onion, and the testes of the newt showing the developing spermatozoa.

We have received a selection of slides from Mr. H. Gunnery, Acomb, York. He has specially devoted himself to the preparation of slides illustrating the phases of development in the embryo-sac and pollen mother-cells of *Lilium* spp. The slides we have examined are very good indeed. Special mention may be made of one, showing the embryo-sac containing two daughter-nuclei resulting from the first division of the nucleus of the megaspore. Mr. Gunnery has also sent for examination sets of botanical slides, designed to meet the requirements of the Intermediate Science and Board of Education Examinations. All the types are well illustrated in these sets, which are very reasonable in price.

E. LEITZ (LONDON) AND R. WINKEL (GÖTTINGEN).—We have received from E. Leitz (London), Catalogues Nos. 7 and 8, devoted to photomicrographic apparatus, and projection apparatus and drawing appliances involving the principle of projection. These catalogues give details of new apparatus specially designed to meet the most recent requirements. In this connection attention may be drawn to the photomicrographic apparatus as suggested by Professor Hermann for taking photographs of insects. As an appendix to the list No. 7 there are two plates of reproductions of actual photographs taken with the objectives and apparatus of E. Leitz.

Messrs. H. F. Angus & Co., 83, Wigmore Street, W., have sent us their new list of microscopes and accessory apparatus, by R. Winkel, Göttingen, for whom they are acting as agents in the United Kingdom. The optical instruments of this firm deserve to become better known amongst English workers, and we can cordially recommend the intending purchaser of a microscope to consider this list before coming to a decision. The apparatus listed ranges from the simplest demonstration instrument to that suited for the most exacting research.

ROYAL MICROSCOPICAL SOCIETY, January 18th, 1911.—Professor J. Arthur Thomson, F.R.S.E., President, in the chair.—Mr. T. Chalkley Palmer made some remarks upon a slide of *Surirella elegans*, stained to show the protoplasm which extended in unbroken continuity throughout the tubes of the keels, where, by its streaming, it acted through minute clefts upon the surroundings and moved the diatom to and fro. The special point was that the mount showed R. Lauterborn to be mistaken in assuming that the streaming substance in the keels was gallerte or jelly.—Professor J. Arthur Thomson, the retiring President, took as the subject of his address "The Determination of Sex." He discussed, historically and critically, five theories or sets of suggestions.

(1) It has been suggested that environmental conditions operating on the sexually-undetermined, developing offspring-organism, may, at least, share in determining the sex. The evidence in support of this has in great part crumbled before criticism, and before the counter-evidence of cytologists and Mendelians. But when we think of the gamut of life, we feel it to be rash to exclude even this possibility.

(2) It has been suggested that the sex is quite unpredestined in the germ-cells before fertilisation, and that it is then settled by the relative condition of the gametes (as affected by age, vigour, and so on), or by a balancing of the inherited tendencies which these gametes bear, neither ovum nor spermatozoon being necessarily decisive. The evidence in support of this is very far from satisfactory. Yet in view of some sets of experiments, of R. Hertwig, in particular it seems rash to foreclose the question.

(3) It has been suggested that the sex is predestined at a very early stage by the constitution of the germ-cells as such, there being female-producing and male-producing germ-cells, predetermined from the beginning and arising independently of environmental influence. The evidence in support of this is very strong, both on experimental and on cytological grounds.

(4) It has been suggested that maleness and femaleness are Mendelian characters, and one form of this very attractive theory is that femaleness is dominant over maleness, and that females are heterozygous as regards sex, and males homozygous as regards sex. But there are grave difficulties as well as very striking corroborations.

(5) It has been suggested that environmental and functional influences, operating through the parent, (or, in short, the parent's acquired peculiarities), may alter the proportion of effective female-producing and male-producing germ-cells. See, for instance, Russo's experiments on rabbits. This possibility remains tenable.

(6) It is suggested that there is no sex-determinant at all in the usual sense, but that what determines the sex of the offspring is a metabolism-rhythm, a relation between anabolism and katabolism, or a relation between the nucleoplasm and the cytoplasm. Many sets of facts converge in the inference that each sex-cell or gamete has a complete equipment of both masculine and feminine characters—of which there are doubtless chromosomic determinants. It may be that the liberating stimulus which calls the masculine or the feminine set into expression or development is afforded by the metabolism-rhythm set up in the cytoplasmic field of operations. It may be that this metabolism-relation—between nucleoplasm and cytoplasm, doubtless, and likewise between anabolism and katabolism—leads first and necessarily to the establishment of ovaries or of spermaries, and secondly, either directly, or through the gonads with their internal secretions, to the expression of the contrasted masculine or feminine characters.

(7) This interesting problem still implies a study of uncertainties. But some progress has been made in the last quarter of a century, and especially of late. Three general impressions stand out clearly: (1) That the main steps of progress have rewarded the coöperation of several distinct methods; (2) That the variety of organisms is so great that we should be very slow to argue dogmatically that what holds good in one set must hold good all round; and (3) That what is especially necessary on the part of biologists (according to their opportunities) is a *thätige Skepsis*,—until we arrive at secure conclusions.

This being the Annual Meeting of the Society, the following Fellows were elected as Officers and Council for the ensuing year:—

President, H. G. Plimmer, F.R.S.—Vice-presidents, A. N. Disney, R. G. Hebb, E. Heron-Allen, J. Arthur Thomson.—Treasurer, Wynne E. Baxter.—Secretaries, J. W. H. Eyre, F. Shillington Scales.—Members of the Council, F. W. W. Baker, J. E. Barnard, F. J. Cheshire, C. L. Curties, C. F. Hill, J. Hopkinson, P. E. Radley, J. Rheinberg, C. F. Rousselet, D. J. Scourfield, E. J. Spitta, Sir Almroth E. Wright.—Librarian, P. E. Radley.—Curator of Instruments, C. F. Rousselet.—Curator of Slides, F. Shillington Scales.

ALGA FROM THE SEYCHELLES ISLANDS.—A friend at the Quekett Microscopical Club recently gave me some specimens of an Alga from the Seychelles. Definite information was not procurable as to its exact habitat, but it was believed to be marine and to occur on rocks on the sea shore. Examination under the microscope leaves little doubt that it should be classed with the Lyngbyeae. It does not appear to correspond exactly with a recorded British species and certainly not with any from fresh water. It consists of unbranched filaments of considerable length; these are

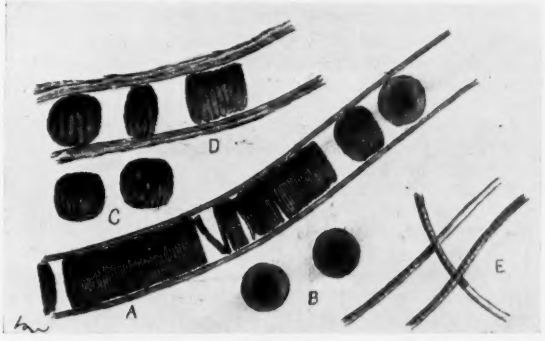

FIGURE 4.

composed of a somewhat thick-walled and strong sheath-like tube, inside which are discs of protoplasm, normally packed closely together; they are without individual cell walls and are, in the specimens given to me (preserved in formalin), of a pale olive green, and are somewhat granular in appearance, Figure 4, A. In what seems to be the young but mature condition these fill the tube, but later they show a tendency to cling together in rouleaux of six or more. Probably these are "hormogones," the non-sexual reproductive bodies of the order. They would emerge from the tube, and being disseminated in the water, develop into new filaments. The discs are lenticular, somewhat thicker in the centre than towards the periphery (Figure B, face view). When packed

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closely together in the sheath this is not evident owing to their compression, but when relieved from the pressure, and a few only adhering together, they form short cylinders, with rounded ends or almost circular collections (Figures C, D). In the older specimens the wall of the filament is greatly thickened and shows a distinct lamellose structure, the outer layers frequently split off, and where injured by sharp bending become broken, ragged and almost fibrous in character. In these cases the protoplasm is reduced in amount, loses its bright colour, becoming brownish, and mostly collects into the masses already described, as at D. The plant differs from the more common species of British Lyngbyeae in two respects. It is much larger than the majority; at E is represented on the same scale *Lyngbya inundata* Kutz, a rather small but plentiful species; the filaments in this case are 4μ in diameter; while those from the Seychelles are from 30 to 35μ, without the sheath. Dr. Cooke gives 25–30μ without sheath for *L. aestuarii*, a large British species found in brackish and salt water, but 7–10μ is the average diameter of the greater number. Also the protoplasmic discs are very much thinner than is usual in our own familiar species; here they average only about 2μ at the edge, and sometimes in young specimens less, looking under moderate magnification like discs of paper filling the thick walled tube.

The literature available on these lowly members of the vegetable kingdom is very scanty, and scattered through pamphlets and proceedings of various societies. If any reader of "KNOWLEDGE" can add information to what I have supplied, it would, no doubt, be welcome to many interested in the study of the lower Algae.

J. B.

QUEKETT MICROSCOPICAL CLUB.—January 24th, 1911, Professor E. A. Minchin, M.A., President, in the chair. Through the courtesy of Mr. E. M. Nelson, a note on the "Amician test" (see "KNOWLEDGE," 1910, page 326), by Mr. F. J. Keeley, of Philadelphia, was read. Mr. Keeley possesses a balsam-mounted slide, labelled "*Navicula Amicii*, Florence, Italy. From Professor Amici to C. A. Spencer." It is a fresh-water gathering and contains, besides a large proportion of typical *N. rhomboides*, a few valves under 50μ in length which form a class by themselves on account of their extreme delicacy and transparency. The author gives measurements of twenty valves and the number of transverse striae per ·01 millimetre in five typical specimens. From these particulars, Mr. Nelson considers the identity of the Amician test with the "English *N. rhomboides*" finally determined.—Mr. C. F. Rousselet, F.R.M.S., described and exhibited preparations and drawings of three new species of Rotifera. These are *Anuraeopsis navicula*, *Brachionus satanicus* and *Brachionus havanaensis*. These will be fully described and figured in the next issue of the Club's *Journal*.—Mr. R. T. Lewis, F.R.M.S., read a paper "On the larvae of Mantispa." He referred to the great apparent similarity between mature specimens of the Mantidae family and those of the sub-family Mantispidae. The wing structure, however, places the Mantis family amongst the Orthoptera and the Mantispidae with Neuroptera. The Mantidae construct a curious capsule or oötheca in which the eggs are laid in symmetrical rows and are entirely covered in from view, while the eggs of Mantispa are laid singly, each mounted on a slender stalk. On first emerging from the egg the young Mantis closely resembles the adult except as to size, colour, and the absence of wings. In Mantispa, the larva on emerging bears not the slightest resemblance to the perfect insect (a full description with drawings and exhibition of specimens was given). On leaving the egg the larva bores its way into the ovisac of a spider and feeds upon the eggs, or young, until it has changed its skin a second time. The legs then disappear, the head is reduced in size and loses its antennae, and the larva becomes a helpless fleshy grub, which presently spins a cocoon. Emerging from this it passes through two more moults and becomes a full-grown neuropterous *Mantispa*.

Mr. H. Gunnery, of Acomb, York, sent for exhibition a number of preparations, chiefly botanical, some especially fine of nuclear division in *Lilium*. These were shown under a number of microscopes kindly lent by Mr. C. Baker. Mr. Gunnery also sent a number of lantern slides, mostly photo-micrographs. These were projected on to the screen. The thanks of the meeting were accorded to Mr. Gunnery and to Mr. Baker.

ORNITHOLOGY.

By HUGH BOYD WATT, M.B.O.U.

SPEED OF FLIGHT OF BIRDS ON MIGRATION.—Gätke in his well-known work on "Heligoland as an Ornithological Observatory" (1895), has a chapter on the velocity of flight of passing birds, in which some estimates of so high a value were given as to cause not a little surprise. The speed of Hooded Crows was stated to be one hundred and eight geographical miles per hour, and that of the Northern Bluethroat as one hundred and eighty; and Plovers, Curlews, and Godwits, were noted in numbers as crossing the island, over a measured distance, at a rate of nearly four miles in one minute.

A series of observations made in the autumn of 1909, under the direction of Dr. J. Thienemann, at the Migration Observatory at Rossitten (East Prussia), give very different results from Gätke. At Rossitten allowances were made for the factors influencing the birds (such as wind), and the following figures are the average results for the species named, calculated to English miles. (See *British Birds*, January, 1911, page 260.) They are here placed in order, from the lowest speed upwards:—

Sparrow-Hawk	25⅞ miles	Brambling	32¾ miles
Lesser Black-backed Gull	31 „	Siskin	34¾ „
		Linnet	34¾ „
Great Black-backed Gull	31¼ „	Peregrine Falcon	37 „
		Crossbill	37⅛ „
Hooded Crow	31¼ „	Jackdaw	38½ „
Rook	32½ „	Starling	46⅓ „
Chaffinch	32¾ „		

There are curious contrasts in these figures, and it seems clear that no fixed conclusions can be drawn until many further observations have been made and coördinated.

UNTOWARD FATE OF AN EGG OF THE GREAT AUK (*Alca impennis*).—Mr. E. Bidwell, in the current number of the *Ibis* (January 1911, page 184), tells a curious story of disregard of an ornithological treasure in the form of an egg of this extinct species. For about twenty years Mr. Bidwell has known of the existence of an egg in a small museum at Dinan, France. In September last, along with Mr. Henry Stevens, he visited the place with the intention of photographing the egg. The Castle (lately a prison) was found to have been made into a museum, but not many natural history specimens were exhibited, and the curator knew nothing of any Great Auk's egg being in the collection. The birds and other animals had been considered not worth moving, and on the previous afternoon had all been stored in an attic, at the Hotel de Ville. There, on the floor, amidst a jumble of stuffed birds, the remains of the Great Auk's egg were found. Mr. Stevens photographed the two largest fragments, and his photographs were shown by Mr. Bidwell, at a recent meeting of the British Ornithologists' Club. The price of a good specimen of this egg at present is about £250.

THE CENTRAL NEW GUINEA ORNITHOLOGICAL EXPEDITION.—The British Ornithologists' Union expedition has suffered a further loss by the compulsory retiral, through ill-health, of Mr. Walter Goodfellow, from the leadership. Capt. C. G. Rawling, surveyor to the party, has been appointed to take command. The arduous character of the undertaking receives further emphasis from the last report published (*Ibis*, January 1911, page 186). The camp and surrounding country had been completely flooded by the River Mimeka, and when the floods subsided the whole camp became a bog. Headquarters were then removed to the Waitakwa River for a further advance.

IRISH BIRDS—NEW RACES OR FORMS.—Visitors to the Natural History Museum, South Kensington, at present,

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will see amongst the British Birds, specimens of Coal-Tits with freshly-written labels bearing the name Irish Coal-Tit (*Parus hibernicus*). Mr. W. R. Ogilvie-Grant has recently described this bird as a new species and thus named it (*Bulletin British Ornithologists' Club*, Vol. XXVII, pages 36 and 37), on the strength of certain differences from the British Coal-Tit. It would seem, however, that the new form has yet to make good its claim to specific rank, sound critics being inclined to regard it rather as a geographical form.

This makes the third Irish bird which has recently been described and named as distinct from recognised species. The other two are the Irish Dipper named *Cinclus cinclus hibernicus*, by Dr. Ernest Hartert, and the Irish Jay named *Garrulus glandarius hibernicus*, by the same writer and Mr. H. F. Witherby.

HOW MANY KINDS OF BRITISH BIRDS ARE THERE?—The latest authoritative "List of British Birds" is by Mr. W. R. Ogilvie-Grant (1910) and enumerates four hundred and forty-two species. An analysis of the grouping adopted by the writer (which is the same as that used in the Natural History Museum, South Kensington), gives the following instructive figures:—

133	species are resident and breed.	=185 breeding species.
52	species are regular summer visitors, and breed	
55	species are regular autumn, winter or spring visitors; not breeding.	
9	species are occasional visitors; used to breed.	
192	species are occasional visitors; never known to breed. To this number the American Pipit, mentioned in the last number of "KNOWLEDGE" (page 76) falls to be added.	
1	species is extinct (Great Auk).	
Total 442	species admitted unquestionably.	
3	varieties are named in the List, but not numbered.	
35	species, of which the history is doubtful, are named in the List within brackets, and are not numbered.	
480	birds in all are thus found named in this List.	

In the scientific names throughout this List, binomials only are used, the author having, with sound judgment, not adopted the new trinomials which are being used now by various writers.

NOTES FOR CORRESPONDENTS.—D. N. H., Chesham. —OWLS are not uncommon at Hampstead, and recently I have heard two kinds calling. On 1st May, 1910, I saw a "Brown" Owl (probably *Syrnium aluco*), seated high up in an ash tree in Platt's Lane, mobbed by two noisy Mistle-thrushes and a Blackbird, which it treated with unmoved contempt. The Barn-Owl (*Strix flammea*) is known to nest each season, and the Long-eared Owl (*Asis otus*) has nested in Ken Wood.

The MARSH-TIT (*Parus palustris*, or, if a trinomial is used, *P. p. dresseri*) is not rare in Bucks, and nests, but it may be local in its distribution, as it is in other districts. If the bird you saw was feeding it may have been taking small molluscs, as it is almost omnivorous.

Two forms of "Marsh" Tit are now recognised in this country. The new one is named the British Willow-Tit (*Parus kleinschmidti* or *P. atricapillus kleinschmidti*), and has been recorded from so many places that a careful examination of all "Marsh" Tits met with should be made by observers. For description, see Witherby's "British Birds," Vol. I., pages 23, 44, and 214 (1907), and Vol. IV., pages 146 and 284 (1910–11).

PHOTOGRAPHY.

By C. E. KENNETH MEES, D.Sc.

STANDARD LIGHT SOURCES.—Inasmuch as photographic investigations are mainly concerned with the measurement of the effects of light, it is naturally of great importance that a standard source of light of known strength and constancy should be readily available. Unfortunately, neither the production nor the measurement of light are susceptible of the very accurate control possible to other sources of energy, the accuracy of measurement being limited by the difference in intensity which can just be perceived by the eye when two adjacent patches are illuminated; while the production of a standard light depends at present on a set of definitions of a standard lamp, which has resulted in the introduction of a large number of different standards more or less harmonized by photometric comparisons.

There is, indeed, no international standard of light in the sense in which the "volt" and "ampere" form electrical standards: although the British standard which is known as the "candle," and in practice is the light of a Pentane lamp, which has been adopted by most countries, the chief exceptions being Germany and Austria, of which the standard is the "hefner," the light of an Amyl-acetate lamp, of which the intensity is nine-tenths that of the standard candle.

Attempts have been made to introduce as international standards the light given by platinum at its melting-point, or by platinum foil heated by a standard current. But the practical difficulties attending the use of these methods seem to have prevented their general employment.

For photographic purposes, what is required is an accurate secondary standard, but the difficulties here are even greater than in visual work because lamps of different kinds and of the same visual intensity, do not produce at all the same effect upon a photographic plate, owing to differences in the spectral quality of the light produced.

The light by which photographic plates are generally used is daylight, and this differs so greatly in composition from artificial light sources that comparisons of plates made by artificial light sources may be most misleading when the plates are used by daylight, especially in the case of orthochromatic or panchromatic plates. This difficulty may be overcome by special methods of screening the light, and what is required for photographic investigation is, therefore, a method of producing light sources of constant intensity, which can be referred to some primary standard. The intensity of these light sources should be between one and four candles and they should be capable of burning for at least fifteen minutes without attention and without a variation greater than one per cent.

When the subject was discussed at the last International Congress of Photography the general opinion of the speakers seemed to be that the choice for such a secondary standard lay between acetylene burners and small metal filament electric lamps; the former being largely used in France and England, while in Germany the electrical standard is more favoured. An acetylene burner giving a single cylindrical jet of flame, from which a small portion is selected by means of a hood having a horizontal slit, will easily give an accuracy of one per cent. and has many advantages; notably, that it will burn for a long time without any attention, provided that the pressure in the generator is constant. The chief disadvantage of acetylene standards is that for accuracy they require very large generators and they are consequently rather expensive to instal, while it is impossible to render them portable.

An examination of small four-volt metallic filament lamps has shown that they will be constant to one per cent. if the voltage is maintained constant to a one-hundredth of a volt which can be done with comparative ease by means of a potentiometer, and as different lamps can be arranged with series resistances to give the same candle power for the same impressed electro-motive force, it should be possible to prepare an electric secondary standard without great difficulty.

The chief objections to these small lamps as standards—the rapidity with which they age—is of little importance in photographic work, where the total duration of exposures in a day's work would be exceedingly small.

It may be remarked that there seems to be an increasing tendency to use small metallic filament lamps, run off accumulators, as standards, especially in simple photometers of the portable type, and that in many cases these lamps are simply assumed to be constant without any control whatever. They are, in fact, very far from constant, not only giving a different intensity after the accumulator is charged, or when it is nearly

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exhausted, but decreasing rapidly from the time when the accumulator is switched on for five or ten minutes. Lamps used in this way may easily give rise to errors of ten per cent. or more, an amount which cannot often be considered negligible. The question as to the "primary" standard to be adopted for photographic purposes is still quite undecided, and is, probably, the most important problem to be considered by the next International Congress of Photography.

THE THEORY OF THE IRIS DIAPHRAGM.—Mr. C. F. Lan-Davis recently read before the Optical Society a paper in which he worked out the geometrical theory of the iris diaphragm, showing the conditions which will produce the maximum aperture, both for complete closing and for closing to a known aperture. The aims in designing an iris diaphragm are to obtain:—

The greatest aperture consistent with the smallest opening,
A long scale with equal division,
Light weight,
Ease in working,
Freedom from failure, and
Reasonable cost.

The factors which can be varied are the position of the pin in the fixed plate, the position of the pin in the slotted plate, width of the leaf, the length of the leaf, the number of the leaves, and the angle of the slots. For the greatest possible aperture the pins should be placed at the opposite extremities of the leaves, and twenty-five leaves are required. The maximum aperture obtainable is eighty-two per cent. of the total diameter of the iris, and no increase in the number of leaves will give a greater opening. If, however, the smallest apertures are not required, the number of leaves may be reduced or a greater aperture obtained.

The length of the scale is governed by the position of the pin, while by altering the angle of the slot, the division of the scale can be made more or less even without altering the total length of the scale; but the angle of the slot can only depart slightly from the radial direction without introducing uncertainty in setting.

THE EXHIBITION OF THE ROYAL PHOTOGRAPHIC SOCIETY.—The Royal Photographic Society will hold its Annual Exhibition during the month of May, at Prince's Skating Club, Knightsbridge.

In addition to the usual Pictorial Section, Section 2 will be devoted to photographs selected for their technical excellence; Section 3 to colour photographs, including transparencies by the screen-plate processes; Section 4 to Natural History photographs; and Section 5 to Scientific photographs.

As Sections 4 and 5 are of special interest to the readers of this column it may be desirable to give the names of the members of the selecting committees of these Sections, who will both select the pictures to be hung and award medals. The judges for Section 4 dealing with Natural History will be Messrs. W. Farren, F. Martin-Duncan, O. G. Pike and Dr. Francis Ward; while those for Section 5, which consists of photographs showing the application of photography to scientific objects, such as photo-micrographs, spectra, astronomical photographs, and radiograms, will be Dr. W. Deane Butcher (X-ray work), Messrs. Chapman Jones, J. W. Ogilvy (photo-micrography), W. Shackleton (astronomy), Major-General Waterhouse, and the writer.

Pictures must be sent in by Monday, April 24th. Entry Forms and Regulations can be obtained from the Secretary, 35, Russell Square, W.C.

PHYSICS.

By A. C. G. EGERTON, B.Sc.

GENERAL.—There is so much that is of very great interest in the physical papers that have recently been published that it is quite difficult to choose those which are of the greatest general interest and demonstrate the advance that is being made in the various branches of physics. Lord Rayleigh has been investigating the perception of colour. Sir J. J. Thomson is perfecting a means of analysing the nature of a highly rarefied gas which he came upon in his studies of positive rays. Sir William Ramsay and Dr. R. W. Gray have accomplished a wonderful feat in weighing the emanation of radium. These are a few instances of the great activity that prevails in every branch of physics.

NATURE OF THE X-RAYS.—There is considerable controversy at the present time about the nature of X-rays. Professor Bragg advocates the view that the X-ray and the γ-ray emitted by radioactive substances, consist of an electron bearing with it a circumscribed positive electrification sufficient to neutralise the negative charge—this has been termed a "neutral pair." The older view, which originated with Sir George Stokes, was that the X-ray was an ether pulse travelling outwards and with ever-extending front. On this idea, as the distance from the source increased, so the energy at any point on the front of this spasmodic wave decreased. The X-rays and γ-rays give rise to secondary rays when they fall upon substances; and these rays consist of β particles. β particles are electrons such as radium ejects; they are precisely similar, though more rapidly moving, to the kathode rays obtained when the electric discharge is passed through vacuum tubes. Now it is found that the X-rays and especially γ-rays are able to liberate these secondary rays and to ionise the gas through which they pass at considerable distances from the source. This fact is difficult to explain on the pulse theory, but it is what would be expected if the X or γ-ray is a discrete particle moving at a great speed, comparable with that of light.

Professor Bragg discussed this most interesting question in his lecture on the kinetic theory of a fourth state of matter at the Royal Institution, on January 27th. He pointed out a similarity between the molecular kinetic theory, which deals with the collisions and motion of molecules, and the motion of the radiations from the radioactive elements—α, β, γ rays—and of X-rays. There are striking differences and striking similarities. Molecules, when they collide with each other, do not interpenetrate, but rebound when their spheres of influence touch. The α particle or other ray is able, in virtue of its small size and extreme velocity, to penetrate the atom it meets. The effect of the penetrated atom on the α or β particle is such that knowledge of the internal arrangement of the centre of force inside the atom may be obtained.

The resemblance between the motion of molecules and that of these rays is not only that they both move in straight lines and are darting about to and fro with great speed and are undergoing frequent encounters, but also it appears that in each case the sum of the energies of the colliding particles is the same before and after impact. An α particle, for instance, collides with an atom—the particle is moving with such velocity that although the atom abstracts part of the energy of the particle, yet the α particle (whether it be the same or another) emerges in the same direction, and with a kinetic energy equal to that of the original particle, less the energy absorbed by the atom. The latter quantity is proportional to the square root of the atomic weight—a remarkable fact. Eventually the α particle is so slowed down by collisions that it is easily deflected from its course on an encounter with an atom and moves in a more random fashion, splitting up the molecules of the gas it encounters into electrically charged "ions."

It appears that the secondary rays produced by X-rays are formed according to the same law of equal energy before and after impact, and it would follow, thus, that their nature is probably discrete; and further, since they are undeflected by magnetic and electric fields, that they are neutral particles.

But ultra-violet light has the power of setting free β particles from metals on which it impinges, and it has long been considered to consist of waves of short length.

Professor Bragg's theory cannot yet be considered to be quite complete.

THE ULTRA-VIOLET RAYS.—Professor R. W. Wood has come across a curious phenomenon which he has recently described in the *Philosophical Magazine*. He finds that if a condenser spark is passed between aluminium terminals and the direct light is shaded from the recipient of the light,

whether it be the eye or a quartz photographic lens, that a violet glow is visible in the air in the neighbourhood. It appears that this glow cannot be accounted for by either fluorescence of the gas in which the spark occurs, or by the scattering of the light by dust or moisture particles. The phenomenon is very curious.

The ultra-violet rays are obtained in profusion from the mercury arc, provided the walls of the tube are of Jena "Uviol" glass or quartz: in fact, the rays from these lamps, unless cut off by glass, by which they are absorbed, are most injurious to the eyes. It appears that one single wave-length of the light is capable of penetrating the cornea of the eye and of doing the mischief.

MM. Urbain, Scal and Feige have devised a mercury lamp which gives a pure white light. Taking advantage of the high melting-point of tungsten they have employed an arc between mercury as kathode and tungsten as the positive pole of the arc. The arc is maintained in a vacuum, and the tungsten is only slightly separated from the surface of the mercury. The tungsten gets white hot, while the usual good efficiency of the mercury vapour lamp is attained.

AFTERGLOW IN VACUUM TUBES.—The Hon. R. J. Strutt has been investigating with great skill the glow obtained in "vacuum" tubes containing air, which sometimes occurs after the electric discharge is turned off. He removed the air from the neighbourhood of the discharge, and passed it into a tube, where he could observe the glow and examine the conditions which prevented or improved it. He found that those substances which destroy ozone prevented the production of the glow, and, further, that it was necessary to send a discharge through the air before the glow would appear, even if ozone had been added. In this way he has shown that the effect is due to both ozone and nitric oxide, and is merely a luminescence due to chemical combination, presumably of the nature of the glow obtained on the oxidation of phosphorus.

Mr. Strutt has found more recently that similar most striking glow phenomena are obtained with nitrogen, a blue glow being obtained in the presence of iodine, while metals exposed to this nitrogen give out their line spectra.

THE ANNUAL GENERAL MEETING OF THE PHYSICAL SOCIETY.—Professor Callendar, F.R.S., at the Annual General Meeting of the Physical Society, on Friday, February 10th, read a most interesting address on the "Caloric Theory of Heat." He dealt with the much-overlooked and misrepresented work of Sadi Carnot. Carnot began his investigations with the purpose of finding what advantage would be gained by using working fluids other than steam in engines. He was led to the consideration of an ideal heat engine, and showed that if no direct transference of heat occurred between bodies at different temperatures, the transformations of heat and motive power were reversible in such a "cycle." He found that the efficiency of such an engine (or the ratio of the motive power to the quantity of heat which produced it) was the maximum possible, and was independent of the working fluids used. By applying the Caloric Theory of heat, Carnot was able to deduce all the relations between heat and work in reversible processes, and to forestall the subsequent determinations of the mechanical equivalent of heat, by utilising the somewhat rough experimental data which were at his disposal.

The idea of Caloric is similar to the idea of quantity of electricity; if all electrical calculations had to be made from considerations of electrical energy, instead of picturing a quantity of electricity passing from one potential to another, there would be much complication. In the same way, a conception of quantity of caloric passing from one temperature to another, besides that of the energy equivalent to such an operation, would be valuable in simplifying the underlying notions of that somewhat abstruse subject, thermodynamics. Caloric is only another name for Rankine's "Thermodynamic Function," or Clausius' "Entropy." It would be well to point out that the "Calorie" is a measure of thermal energy, which must not be confused with the "Carnot," or unit of quantity of caloric.

Professor Callendar's study of Carnot's work will make it possible to give the student a less abstract conception of heat.

The addresses of the officers of the Society, previous to the reading of the President's address, testified to the flourishing condition of the Society and to its great activity, while it was hoped that many would be led to share its many advantages and become members.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON.

RIGHT AND LEFT-HANDEDNESS.—After all the discussion on this subject it is rather surprising to hear an anatomist of the rank of Karl von Bardeleben saying that our ignorance on the matter is shameful. We cannot state percentages for different races; we have done little in the way of distinguishing different degrees of left-handedness; and we do not know how it is that right-handedness has become so predominant in mankind. Perhaps, one sometimes thinks, each species has its particular asymmetry, just as many great types have. The gibbon and orang are right-handed; the gorilla and chimpanzee are left-handed. To point to asymmetry in the brain, *e.g.*, the stronger backward protrusion of the left cerebral hemisphere, except in typical left-handed people, shifts the problem without solving it. Professor von Bardeleben gives the interesting piece of information that there were last year (1910) in the German army ten thousand three hundred and twenty-two left-handed men. Only 3·88 per cent., however!

FERTILE HYBRIDS BETWEEN BISON AND DOMESTICATED CATTLE.—E. Iwanoff refers to the estate of F. E. Falz-Fein, "Askania Nova," where a number of half-breeds have been produced by crossing *Bison americanus* with domestic cows and with the European Bison (*Bison bonasus* or *europaeus*). Others have been produced—"Three-quarters American Bison and one-quarter domestic *Bos taurus*, and one-quarter American Bison and three-quarters *Bos taurus*." The fertility of the half-breed bison females has been proved. They produce offspring to both American bison and European bison. The male half-breds have sexual instincts, but there is no proof of fertility. But the male of three-quarters bison blood seems to be fertile with the domestic cow.

OVIPAROUS AND VIVIPAROUS.—It is said that some snakes, such as the grass snake, normally oviparous, may become viviparous in the comfortable conditions of captivity. That is to say (for the old terms are as bad as they are difficult to dislodge), the eggs may hatch inside the body instead of outside. E. Roubaud has recently reported an interesting parallel case in insects, namely one of the flies, *Musca corvina* Fabr. In tropical Africa this fly is constantly viviparous all the year round, and at intervals of four days or so. It can continue this reproductive régime as long as the average temperature is not less than 30° C. Now the interesting point is, that according to Portchinsky, the fly is always oviparous in the north of Russia, laying twenty-four eggs, while in the Crimea it produces a large larva viviparously at the end of spring and in summer. The author calls this "seasonal and climatic poecilogony."

BRAIN OF A SILVER-FISH.—Comparatively little has been done in the way of comparing the brains of different kinds of insects. One, therefore, welcomes the study which Otto Böttger has made of the brain of the little wingless insect, *Lepisma saccharoides*, not uncommon in houses, and popularly known as the "silver-fish." It is something of an achievement to be able to present a picture of the minute structure of the brain of such a tiny creature, and it is interesting to notice the investigator's general result—that the brain of this type is in many ways quite peculiar. Indeed it shows parts which have not been seen as yet in any other insect.

LARVAL MANTIDS MIMICKING ANTS. — From a pale emerald-green, walnut-sized nest, sent to the Zoölogical

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Society from the Gold Coast, there emerged a crowd of young mantids, about four millimetres in length, which, "when crawling about the case, looked exactly like a crowd of black ants, their rapid darts and pauses recalling irresistibly the busy method of progression so characteristic of these Hymenoptera." Mr. R. I. Pocock, the Superintendent of the Gardens, observed them carefully, and noticed that it was only when in motion that they resembled ants. When at rest they were seen in their true colours—as Mantises, "raising the fore part of the body and head, folding up their fore-legs, and every now and then swaying gently from side to side, as if rocked by the wind. While thus employed they were seen to be procryptically coloured." That is to say, they were inconspicuous. Mr. Pocock has analysed the resemblance to an ant, and finds that it is partly due to the blackness of the underside of the abdomen, and partly to the habit the moving insect has of curling the posterior half of the abdomen up like a scorpion's tail. This altered the proportions and shape, and in a curious way a white spot on the prothorax simulated an ant's waist. When the young insects attained a length of seven millimetres they lost their ant-like look. Mr. Pocock also directs attention to the conspicuous larva of a Ceylonese leaf-insect, closely resembling a distasteful beetle (*Lycostomus gestroi*), which is also mimicked by two bugs and a moth.

COPEPODS AND ALCYONARIANS. — Colonies of Alcyonarians often harbour small parasitic Copepods, which are known as Lamippids. They are very distinctive little creatures, characteristic in their buccal armature at one end, and in their caudal fork at the other. They have been recently studied systematically by A. de Zulueta, and the result shows, what is so often true of parasites, that each species of *Lamippe* has its particular host. Some hosts may harbour two or three species, but no species occurs on two different hosts. It is impossible not to wonder whether in these cases, and for others like them—Nematode worms, for instance—there may not be "modification species," whose characters are directly due to their immediate environment. It would be interesting to transplant some young Lamippids from one Alcyonarian to another.

SIMULACRA VITAE.—If a weak solution of gelatine is spread on a slide and tiny drops of ferrocyanide of potassium are put on at intervals of five millimetres by means of a pipette, beautiful simulacra of nucleated cells are produced. If fragments of calcium chloride are dropped into sixty grains of silicate of potassium at thirty-three degrees, sixty grains of saturated solution of carbonate of soda, thirty grains of saturated di-basic phosphate of soda, and distilled water up to a litre, then beautiful phantasms arise—"osmotic growths"—like mushrooms and moulds and corals and shells. Professor Stéphane Leduc has given much time to these interesting and fascinating simulacra vitae, and discusses their importance in a recent book ("Théorie Physico-Chimique de la Vie." Poinat, Paris, 1910). There are, of course, osmotic phenomena in organisms, and the more they are studied the better, but it appears to us to be giving an entirely false simplicity to the facts to declare that biology is a subdivision of the physico-chemistry of fluids. This is a survival of the discredited materialistic superstition, and to credit the artificial osmotic growths with nutrition, assimilation, irritability, and a power of development, is a bad instance of an assertion that outstrips its evidence.

THE LEONID FIREBALL OF NOVEMBER 16th, 1910.

By W. F. DENNING, F.R.A.S.

THE Moon being full at the epoch of the Leonid shower in 1910, it appears to have been but slightly observed. A very brilliant member of the stream was, however, seen by various persons who were watching the total lunar eclipse on the night of November 16th.

Mr. J. Cranston, of Giffnock, near Glasgow, saw the meteor at $12^h\ 27^m$. It fell from a few degrees to the right of Algol, almost vertically downwards, bursting in Andromeda. The direction was from between Capella and Ursa Major. It left a tail visible for several minutes. The length of path was about 26°, and when bursting the meteor appeared to equal the size of the moon.

Mr. W. B. Ogilvie, at Greenock, N.B., gives the time as $12^h\ 26^m$. He saw an intensely luminous streak stretching from above the stars, 35, 39, 41 Arietis towards Capella. The streak was broken and the brighter portion lay west of Capella. It was visible to the unaided eye for five minutes.

Miss Helen M. Metcalfe recorded the meteor at Kildare, and Miss Rose Atkinson from Pitlochry, while correspondents to the *English Mechanic* also described its appearance.

There is no question but that the meteor was a brilliant Leonid passing over Scotland and the north coast of Ireland. Its height was from ninety-one to forty-five miles. The radiant point was near 150°+23° in the well-known "Sickle of Leo."

At and near Glasgow the fireball presented a splendid appearance, and the intense light accompanying its sudden outburst astonished many persons. The apparition of this fine Leonid is interesting as proving that the shower returned in 1910, though possibly under a feeble aspect. Thirty-three years ago, viz., in 1877, November 10th to 13th, I recognised it, but it was very feeble.

Tempel's parent comet of the Leonids is now not very far removed from its aphelion outside the orbit of Uranus. Such meteors of this stream as are noticed during the few forthcoming years will, therefore, be at nearly the opposite part of the orbit to the comet. It is known, however, that the stream is an annually visible one, and that the meteors are distributed right around the ellipse, though only feebly so in certain sections of it.

Mr. J. McHarg, of Lisburn, near Belfast, reports that at midnight (Dublin time) he observed a bright flash, and looking towards the stars of Ursa Major he remarked a short, broken meteor-streak, about 1° above the stars δ and γ. The direction of this streak was from the radiant of the Leonids, and a small Leonid shooting star passed through Ursa Major at the time the streak from the fireball was suspended there. It remained three minutes, the portion near the star δ Ursae Majoris moving downwards to below δ, while the westerly section formed a small patch of nebulosity, and continued stationary about 1° above γ.

The position of the streak was evidently influenced by air currents of different velocities and directions in the upper regions of the atmosphere. The singular streak left for three hours by a fireball on February 22nd, 1909, exhibited similar phenomena; while the ends appear to have retained nearly the same position for the long time, the central parts drifted N.W. at the velocity of ninety or one hundred miles per hour.

Mr. C. L. Brook, of Meltham, near Huddersfield, obtained an excellent view of the fireball, and as he is an experienced and accurate meteoric observer his record is of special value. He places the beginning of the luminous course in the region of α Draconis and the whole path as from 205°+60° to 295°+38°. The meteor burst at 293°+44° 20′ and a small section of the streak remained visible without drifting much for five minutes. The meteor ended with a minor explosion before it reached η Cygni.

In deducing the height and length of path of the object, I have had to revise some of the observations. I think the best real path obtainable is that the meteor passed over the sea near Berwick, to nearly above Edinburgh and Glasgow, and westwards over Kintyre, ending north of Rathlin Island off the north coast of Ireland. Several of the observers place the end further west, while Mr. Brook's record indicates that it began earlier in its flight and decidedly east of Berwick. However, a length of flight of one hundred and sixty-five miles and a velocity of thirty miles per second satisfies the observations and cannot well be far from the actual course.

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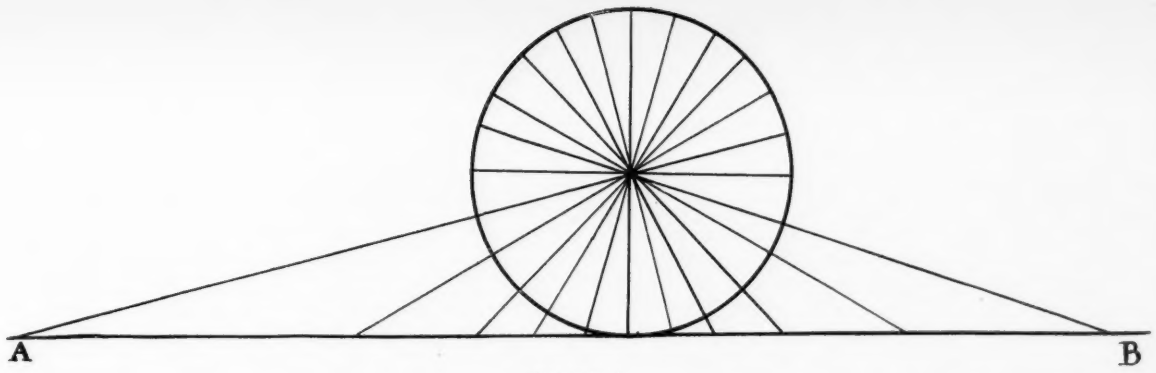

FIGURE 1.

(NOTE.—The line A. B. may just as appropriately be drawn below the circle, or cutting through it. It is here made tangential merely to simplify the measurements to which reference is made.)

A SIMPLE METHOD OF CONSTRUCTING A HORIZONTAL SUN-DIAL.

By CHARLES E. BENHAM.

STRIKE out a circle on a piece of paper. The size is not important, but as some guide it may be mentioned that it will be found that the height of the gnomon of the dial will be a little less than the radius of this circle.

Divide the circle very carefully into 24 equal parts, and at right angles to one of these radii draw a horizontal line (AB, Figure 1) tangential to the circumference. Cut the paper along this line, and produce the 11 nearest radii to the cut edge as shown.

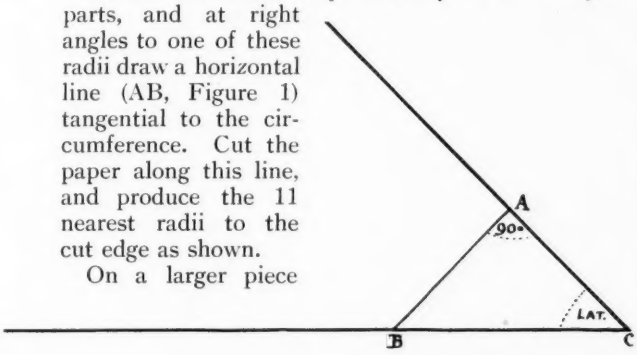

FIGURE 2.

On a larger piece of paper draw two lines at right angles in the form of a ⊤, and to the top line of this ⊤ apply the cut edge, so that its central line touches the centre of the top of the ⊤. Mark off on the top line of the ⊤ all the points where the produced radii meet the cut edge.

Draw two lines meeting at an angle equal to the latitude of the place for which the dial is to be constructed, and form a right-angled triangle (ABC, Figure 2) with this angle for its acute angle C, and with the length of the side AB exactly one radius of your circle. Mark a point on the upright line of the ⊤ exactly the length of BC from the top. Rule lines through all the points on the top line of the ⊤ to this point on the other line, and produce them on through the point. These will be the hour lines of the dial-plate and must be numbered—12 for the central one, with 11, 10, 9, and so on, in order on the left, and 1, 2, 3, and so on, in order on the right. A line parallel with the top of the ⊤ will form the hour line for the two sixes. Of course it is not necessary to number the hours further than 8 in the evening or before 4 in the morning. If half hours are required the original circle must be divided into 48 instead of 24; if quarters, 96 parts.

The gnomon must be a triangle of metal corresponding with the triangle of Figure 2, the base being BC, the point B at the head of the ⊤ and the point C where the hour lines intersect.

This simple method of dialling will incidentally suggest the curious form necessary for a dial at the latitude of the equator—0 degrees.

In this case, the angle at C being 0 degrees, the line AC, instead of sloping downwards, would have to be parallel with the dial face, so that a rectangle would take the place of the triangle for the gnomon. The hour lines, having no point to converge to, would also run parallel with the top of the gnomon, and the dial would take the form shown in Figure 3.

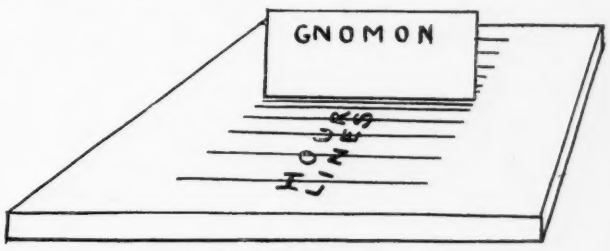

FIGURE 3.

Form of Horizontal Dial adapted to the latitude of the Equator.

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THE CENTENARY OF URBAIN JEAN JOSEPH LE VERRIER.

By F. A. BELLAMY, Hon. M.A., F.R.A.S.

On March 11th, 1911, the centenary of the birth of this most eminent astronomer of the last century will be celebrated. A few words upon this man may not be amiss to the present generation, seeing the time that has elapsed since his death. He was a student at the Ecole Polytechnique at Paris when from twenty to twenty-two years of age. His early work was in the domains of chemistry and engineering; but his first astronomical paper was not communicated to the Academy of Sciences until 1839, on the important subject of the Secular Variations of the Elements of the Orbits of the Seven Major Planets. Further researches upon the same subject were made in the next year or so: the papers are printed in the *Connaissance des Temps* for 1843 and 1844. These memoirs seemed to have excited his energies; for, from 1843 until 1877, he produced an incessant stream of highly-important researches, entailing prodigious labour upon the Theory of Mercury, 1843 (revised in 1859); the Theory of Uranus,—the three famous memoirs were presented to the Academy in 1845 and 1846 (reinvestigated in 1874); Theory of the (Earth) Sun, in 1853 and 1858; Theory of Venus, 1861; Theory of Mars, 1861; Theory of Jupiter and Saturn, in 1872 and 1873; and the Theory of Neptune, 1875 and 1877; these memoirs and the tables based upon them are to be found in the *Annales de l' Observatoire de Paris*, tome IV–XIV, and form an imperishable monument to him; the movements and positions of these bodies given in the nautical almanacs of various nations have for many years depended upon these tables. Of all these separate investigations, those relating to Uranus stand out most prominently before the world, whether it be considered astronomically or generally. Bouvard's tables of Uranus, printed about 1821, were generally used; and it was the increasing difference between those calculated places and the observations which caused Le Verrier, it is said by Arago's request, to commence his researches which ultimately led to the discovery of a new and more remote major planet, Neptune, in the September of 1846. (These memoirs were published in the *Connaissance des Temps* for 1849.) The subject of the visual discovery by Dr. J. G. Galle was recently referred to by the writer, in "Knowledge" for last August and September, wherein it was shown that the receipt, by Galle, of a letter from Le Verrier in September, 1846, asking him to look for a planet in a particular region, which he indicated closely, Galle was soon able, on September 23rd, 1846, by the aid of one of Bremiker's star maps, assisted by d'Arrest's suggestion and help, some say, to detect an object which had a disk and which proved to be the new body sought for by Le Verrier; Le Verrier's letter of October 1st, thanking Galle, is delightful to read.

This triumvirate, Bremiker, Le Verrier, and Galle, all assisted in the discovery; and the following facts are worthy of attention being drawn to them. Bremiker, the star-map maker, was born in 1804, and died almost suddenly on March 26th, 1877, a generation ago. (Parenthetically, it may be added that Heis, also a star-map maker was born in 1806 and died on June 30th, 1877, also suddenly). Le Verrier, born on March 11th, 1811, died exactly thirty-one years after Galle had visually discovered the planet Neptune, September 23rd, 1877. Galle, born a year later than Le Verrier, on June 9th, 1812, lived for sixty-four years, or nearly two generations of astronomers, after the discovery of Neptune, and for a generation after Bremiker and Le Verrier. Bremiker and Galle were both elected Associates of the Royal Astronomical Society on the same day, May 12th, 1848.

In addition to these immense and laborious investigations Le Verrier's attention was particularly attracted to the study of the orbits of comets, especially those of Lexell (though discovered by Messier), Faye, and De Vico (the memoir on Lexell's Comet is considered a classic work); he gave much time to these calculations and achieved what others had hitherto failed to accomplish.

For his grand work he was twice awarded the gold medal of the Royal Astronomical Society; upon the first occasion it was in 1868 for his researches on Mercury, Venus, Earth, and Mars; and in 1876, the year before his death, when his eminent colleague in similar work on the planet Uranus, Professor J. C. Adams, gave a fine address in presenting the medal for researches on the next four major planets. It is a strange fact, looking down the list of medallists from 1846–1876, that neither the theoretical nor the visual discoverer of a new *major* planet should be thought worthy, by the members who formed the R.A.S. Councils during that period, of the award; it is even more strange when one sees the comparatively trivial or almost forgotten work for which some obtained the medal. Was it jealousy? Certainly in 1848 they obtained a clean slate by giving *testimonials* freely, but the merits of the others pale before the immensely superior claim of Le Verrier; it was small honour to him to see his name in that 1848 list, and why were not Galle's and Adams' included?

Le Verrier was appointed Director of the National Observatory, at Paris, in 1853, when Arago died, but left in 1870, owing to difficulties with his colleagues there; he, however, was re-appointed in 1872, and remained Director until his death in 1877. His health was poor for some months before his death, but he was cheered greatly by Gaillot's assistance in getting the computations and in printing the tables of Neptune completed shortly before his death. He was a Grand Officer of the Legion of Honour, and so had a semi-military funeral to the cemetery of Mont Parnasse, Paris.

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REVIEWS.

ARCHAEOLOGY.

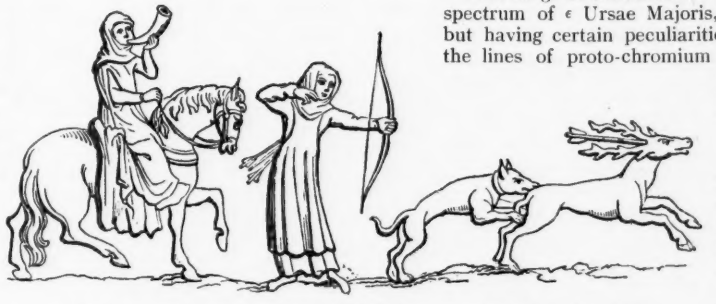
British Costume during Nineteenth Centuries.—By Mrs. CHARLES H. ASHDOWN. 376 pages. 459 engravings. 119 plates. 9½-in.×6½-in.

(T. C. and E. C. Jack. Price 18/6 net.)

We do not pay enough attention in this country to that side of archaeology which deals with the development of the industries of the people, especially as these are concerned with the details of everyday domestic life. It is true that considerable interest is taken in the history of dress, and this, perhaps, for special reasons, but we still have no folk museum in which we can refer to the actual clothes themselves. The task of getting a proper series together becomes increasingly difficult as the years go by. When, eventually, a serious attempt is made to repair the deficiency in our national collections we shall, no doubt, have to depend a great deal on careful reconstructions such as Mrs. Ashdown has made for the purpose of producing the coloured illustrations which embellish her book. As these have been taken, with the help of photography, from real people—and we cannot imagine that the features of English men and women have changed greatly in a few hundred years—we get from the pictures a better idea as to the effect of the costumes than is possible in any other way.

An Anglo-Saxon lady riding on a side saddle.

It is very interesting to the student of the past to study old costumes that survive at the present day—say, like those of the Sister of Mercy and the Blue-coat Boy, and see from what chapter of history they are taken.



A lady riding astride when hunting in the reign of Richard II.

The exaggerations in dress that are so common throughout history are amusing to us, but those of olden times cannot seem to us to be any more idiotic than pictures of those of the present will appear to our descendants. When the clothes are seen on living persons their ridiculousness is not always quite so obvious as it is in the illustrations of a book or it is possible that the Goddess of Fashion would not have quite so many worshippers.

Clothes proper are not the only things which are presented to us by Mrs. Ashdown, and the method of riding by ladies which we have chosen for illustration is a good instance. Women of the lower orders, and ladies when hunting or in a hurry, rode astride, but the side saddle was used from Anglo-Saxon times onwards by the quality.

Ladies using the side saddle (14th Century).

ASTRONOMY.

Researches on The Chemical Origin of Various Lines in Solar and Stellar Spectra.—By FRANK E. BAXANDALL, A.R.C.Sc. 77 pages. 12-in.×9½-in.

(Wyman & Sons, for the Solar Physics Committee. Price 4/6.)

A collection of six papers, the first giving the results of a comparative study of the spectra of the sun and lower type stars, in relation to the sunspot spectrum. During the seven years the work has been in progress, several papers bearing on the subject have been published from Mount Wilson Observatory and are referred to, and the results compared with those obtained at Kensington. The stars compared with the sun are Capella and Arcturus. The former yields a spectrum very like the general solar spectrum, but the latter is found to be very similar to sunspot spectra. The elements which appear to have the largest share in producing the distinctive spectrum are vanadium and titanium. The conclusion is drawn that there are probably nearly similar conditions either as to temperature or electrical excitation in sunspots and stars of the Arcturian class. Further it is considered that the Sunspots and Arcturus are lower in temperature than the general photosphere and Capella.

Part II. gives the results of an investigation of the spectrum of ϵ Ursae Majoris, a star of Sirian type, but having certain peculiarities. One result is that the lines of proto-chromium are found more pronounced than in the spectrum of any other known star.

Part III. deals with the presence of nitrogen lines in stellar spectra, detailing the relative intensities of the stronger lines in the stars β, γ κ, ϵ, ξ, and ι Orionis It is noticeable that in spectra of stars of a higher class than ι, or a lower than β, no nitrogen lines are found.

Part IV. consists of lists of enhanced lines in the spectra of some metals not published previously.

Part V. gives tables of wavelengths of known lines of use in studying the radial velocity of stars.

Part VI. brings together in order of wavelength a number of pronounced lines, met with in various celestial spectra, but, so far, not identified with any known terrestrial substance. The contribution is distinctly a useful one; the last part very specially may be helpful to the laboratory worker—a list of eighty-two lines to be watched for. Helium is now a well-known gas, yet for many years it was only known as a bright line in the solar chromosphere, very occasionally recorded dark on the disc. What may not these eighty-two lines, as yet unknown, mean? F. C. D.

These illustrations are reproduced by the courtesy of Messrs. T. C. and E. C. Jack.

XUM

Norton's Star Atlas and Telescopic Handbook.—By ARTHUR P. NORTON, B.A. 20 pages. 16 maps. 11¼-in.×8¾-in.

(Gall and Inglis. Price 5/- net.)

This is a star atlas on good paper of convenient size and weight. The author has evidently taken great care and spent much time in attaining the production of a useful atlas suitable to possessors of telescopes of moderate size. A map of the moon is given as a frontispiece, and various information relating to the relative magnitudes of stars, terms and abbreviations used in astronomy, notes on star nomenclature, sun, moon, planets, stars, nebulae, comets, and meteors; care and use of the telescope, hints on observing, and Arabic names, are given on the first nineteen pages; then follow sixteen maps, or rather eight double maps, for the northern sky is given on the right-hand side, and the southern sky is continued on the left-hand side. On the back of each map is abundant information concerning the principal double stars, variable stars, clusters and nebulae. There is also, at the beginning, a replete index of contents and, at the end, an index to the constellations with the dates of culmination for 9 p.m. and midnight. The obvious faults are three: (*a*) the maps err by containing too much information in giving star catalogue references, no doubt convenient for day use, but tending to render the stars on the maps less conspicuous in a dim light at night; (*b*) giving the maps for epoch 1920·0 is needless for such small scale maps; much better have made the epoch 1900·0, they would then have agreed with the International Survey maps and catalogues, and still have been sufficiently accurate for general use for many years to come; (*c*) binding the equatorial portion of each map in the back of the atlas is a serious inconvenience and loss of an important part of the sky; a different form of binding, an unprinted space in the fold of each double map, or the mounting of the maps on guards would have prevented this loss. F. A. B.

BIOLOGY.

Survival and Reproduction—A New Biological Outlook.—By HERMANN REINHEIMER. 410 pages. 8½-in.×5½-in.

(John M. Watkins. Price 7/6 net.)

This book is a continuation of "Nature and Evolution," in which the writer claims to have propounded a broader and more apposite theory than that of "natural selection" to explain evolution, and in the introduction we are given ninety-eight points and propositions which are contained in the previous volume. Mr. Reinheimer, so far as we are able to make out, seems to have set up in his mind some sort of rules of behaviour to which he considers that creatures should conform. For instance, after comparing beetles with the less numerous lepidoptera, he says:—"Now the construction that I wish to place on these facts is to the effect that as soon as the law of animal alimentation is seriously infringed—as soon as animals habituate themselves to feed on animal instead of vegetable matter—multiplication of individuals and frequently of groups termed species proceeds at a dangerous and chaotic rate (pathologically), involving violent clashes and struggles between organisms which are of their own making." If this be true we should not expect a declining birth-rate among meat-eating people. In another place he presents the case of cannibalism among whelk embryos as a "striking picture of parasitic retribution," and with this we are asked to compare "the rectitude of life" in the higher organisms.

Many interesting biological facts are mentioned in the book, but we are not convinced by the arguments.

BOTANY.

Alpine Flowers and Rock Gardens.—Described by WALTER P. WRIGHT, with notes on "Alpine Plants at Home," by WILLIAM GRAVESON. 292 pages. 4 coloured plates. 15 figures. 9¼-in.×6½-in.

(Headley Brothers. Price 12/6 net.)

Garden lovers will welcome another helpful volume from the pen of Mr. Walter P. Wright. Of late years Alpine plants have greatly gained in popularity, probably owing in no small degree to increased facilities for travel, and consequent interest in mountain flora. A rock garden has many obvious advantages, not the least being that the space required need not necessarily be extensive, and hence, given the requisite knowledge, it is quite possible to possess a successful and very interesting rock garden even in the suburbs.

Apart from the wealth of information contained in this book, its great charm lies in the beautiful coloured photographs of rock plants in their native haunts, which occur every few pages, the brilliant colouring of the flowers on the brown mounts making the volume exceedingly attractive.

GEOLOGY.

Smithsonian Miscellaneous Collections. Vol. 53. No. 6.—*Cambrian Geology and Palaeontology. Olenellus and other Genera of the Mesonacidae.*—By C. D. WALCOTT. Pages 231–422. 22 plates.

No. 7. *Pre-Cambrian Rocks of the Bow River Valley, Alberta, Canada.*—By C. D. WALCOTT. Pages 423–431. 3 plates.

Vol. 57. No. 1.—*Cambrian Geology and Palaeontology. II. Abrupt Appearance of the Cambrian Fauna on the North American Continent.*—By C. D. WALCOTT. Pages 1–16. 1 Map. 6½-in.×9¼-in.

(Washington: Smithsonian Institution, 1910.)

These three publications are in continuation of the lifelong work of Dr. C. D. Walcott on Cambrian and Pre-Cambrian geology and palaeontology. The first is a complete monograph on Olenellus and its allies. Under the family Mesonacidae are included the genera *Nevadia*, *Mesonacis*, *Elliptocephala*, *Callavia*, *Holmia*, *Wanneria*, *Paedeumias*, *Olenellus*, *Peachella*, and *Olenelloides*, with thirty-three species at present known. *Nevadia* is the most primitive form: from it spring two lines of descent, one through *Callavia*, *Holmia*, and *Wanneria*, probably leading on to the Middle Cambrian *Paradoxides;* the other through *Mesonacis*, *Elliptocephala*, *Paedeumias* and *Olenellus*, becoming extinct in Lower Cambrian times with the degenerate form *Olenelloides*. All known species of the Mesonacidae are confined to the Lower Cambrian. This fine monograph is illustrated by twenty-two excellent plates, containing two hundred and fifty-eight figures.

In publication No. 7, Dr. Walcott describes his field work on the Pre-Cambrian of the Bow Valley, Alberta. These rocks are unaltered sediments lying unconformably beneath the Cambrian, and, as far as known, are unfossiliferous. The formation names Hector and Corral Creek (in descending order), are proposed for them, and they are correlated with the Camp Creek and Kintla-Sheppard series of Montana, South-Western Alberta, and South-Eastern British Columbia.

The fascinating topic of the abrupt appearance of indications of life in the Cambrian period is discussed in the last publication under review. This paper is Dr. Walcott's contribution to the debate on "The abrupt appearance of the Cambrian Fauna," at the eleventh International Geological Congress, at Stockholm, this year. Brook's views as to the origin of life in the open ocean are adopted. This pelagic life is believed to have become adapted to littoral and shore conditions during the period of Algonkian continental elevation, which was of sufficient duration to permit of the development of the types now found in the basal Cambrian rocks. The sediments and fossils of the Lipalian era (i.e., the period between the formation of the Algonkian continents and the earliest encroachments of the Lower Cambrian sea), are absent from our present land areas, the continents having been high above sea level during the development of the Pre-Cambrian fauna. The Lipalian sediments are probably still buried beneath the oceans. This theory depends primarily on the absence of a marine fauna in the known Algonkian rocks, most of which, such as those of the Cordilleran geosyncline, are believed to have been deposited in fresh or brackish waters. It appears to depend also on a rigid acceptance of the theory of the permanence of ocean basins and continental areas.

XUM

A Textbook of Geology.—By P. LAKE, M.A., F.G.S., and R. H. RASTALL, M.A., F.G.S. 494 pages. 134 figures. 32 plates. 5½-in.×8¾-in.

(Edward Arnold. Price 16/- net.)

Geological students have long needed a textbook to bridge the gap between the elementary manuals and such detailed works as Sir A. Geikie's great treatise. They have their need satisfied in the book under review, which meets a distinctly "felt want." In its five hundred pages the student will find most geological topics dealt with in clear concise paragraphs informed with the latest results of research. The book is divided into two parts; the first, dealing with physical geology, has been written by Mr. Rastall; the second, on stratigraphical geology, by Mr. Lake. The treatment adopted, as acknowledged in the Editor's preface, is frankly Lyellian. In accordance with this method, petrology and palaeontology are necessarily dealt with only to such an extent as is required to appreciate their place in geological science. Their modern development is regarded as altogether too extensive to be included in a work on the principles of geology.

We have nothing but praise for that portion of the book which deals with physical geology. The arrangement and selection of material is good. Some of the latest results of research on British rivers, and on North American glaciers, to mention only two subjects out of many, are here rendered in an easily accessible forms, for the first time in an English text book. The whole section gives evidence of very careful and extensive reading on the part of the author. Similar praise must be accorded to the stratigraphical part of the book, which is headed by a good chapter on the often-neglected principles of stratigraphy. A welcome feature to British geologists is the incorporation of the latest results of stratigraphical work in Wales, Cornwall and elsewhere. Only British stratigraphy is dealt with, as the scope of the book does not permit the consideration of foreign deposits. The work is in general so thoroughly done that it is surprising to find no account of the recent material development of our knowledge of the great Dalradian series of the Scottish Highlands by the Geological Survey officers and others. The plateau lavas of the Carboniferous in Scotland, except in the Garleton Hills, are mostly very basic olivine basalts, not andesites, as stated on page 371. In spite of minor defects, we have in this section the best, fullest and most modern account of British stratigraphy. The text is illustrated by many excellent plates and informative diagrams. There are two misprints in a single paragraph on page xii., and a transposition of lines on page 140, but these are the only blemishes we have been able to discover in a well-printed book. The authors are to be congratulated on this excellent and important summary of geological science, which should be in the hands of all geologists.

MEDICINE.

Induced Cell-reproduction and Cancer. — By HUGH CAMPBELL ROSS, M.R.C.S., L.R.C.P. 291 pages. 125 plates. 9¼-in.×6-in.

(John Murray. Price 12/- net.)

In this large and interestingly-written book the author describes researches which he has recently carried out by a special and, for the most part, original method, upon the white blood corpuscles. A small quantity of blood is spread out on the surface of a film of jelly, containing stains and other substances dissolved in it, and the whole is then covered with a cover-slip and examined. The stain is slowly taken up by the leucocytes and lymphocytes and various changes are observed to take place in these cells, depending on the nature of the dissolved substances. What the writer describes as division of the white blood corpuscles can be watched on the stage of the microscope. In the case of the lymphocytes it is quite possible that these changes may at times constitute a true physiological division; but it would appear probable that the leucocytes never really divide, as they are fully formed and specialised cells, and that what the author has observed are really degenerative changes taking place in cells that are slowly dying. At any rate, as the writer very justly points out, no one has previously observed the division of the ordinary polymorphonuclear leucocyte, though this has been searched for during half a century. Among other substances, extracts of decomposing animal tissues have the power of inducing the above changes in the white blood cells, and the suggestion is very reasonably brought forward that the presence of these substances may be the determining factor of the cell proliferation that takes place in a healing wound. The last few chapters are devoted to some theoretical considerations regarding the cause and cure of cancer.

The book is well written and well illustrated by microphotographs. Some of the observations described in it have already appeared in the journals, but do not appear to have been well received by pathologists generally.

METEOROLOGY.

Southern Hemisphere Surface-Air Circulation. — By WILLIAM J. S. LOCKYER, M.A. (Cantab.), Ph.D. (Göttingen), F.R.A.S. 110 pages. 15 plates. 12-in.×9½-in.

(Wyman & Sons, for the Solar Physics Committee. Price 6/-.)

A most interesting and instructive study of air movements in the southern hemisphere during the winter—April to September—months. There appear to be a series of anti-cyclones, or high pressure swirls or eddies, travelling constantly eastward. The areas of these vary somewhat, being larger in winter, and smaller in summer. The centres in winter travel nearly along parallel 34° south, the circulation of the eddy being in the direction S.E.N.W. They appear to travel over land at the mean rate of about 11°·5 daily in longitude, but over the oceans at about 9°·2, giving a mean rate of 10°·7 per day around the earth, completing the circuit in 33·6 days. The path of these systems is instructive. They seem to follow almost truly along the line of latitude across the wide expanse of the Pacific Ocean, then, when met by the Andes chain near the west coast of South America, they turn very abruptly south, and after breaking through the mountains curve north again, and travel direct over the Atlantic, but follow the coast-line south of Africa. Thence direct across the Indian Ocean and Australia. Again, over the South Pole there is another anti-cyclonic region, not indeed having the pole quite central, but crushed down, as it were, directly below South America. Between the anti-cyclonic systems there travel in the same direction, but rotating S.W.N.E., a series of low pressure eddies or cyclones. The path of these is near latitude 60° south. For the "reason why" of these movements we cannot do better than advise those interested to study the memoir. The results are obtained from the observations made at about fifty stations, supplemented by the work at eight stations occupied by Antarctic expeditions. In going through the volume it seemed unfortunate that there could be no report from Tristan Da' Cunha, which would be like a connecting link between America and Africa.

PHYSIOLOGICAL CHEMISTRY.

Practical Physiological Chemistry.—By R. H. ADERS PLUMMER, D.Sc. 270 pages. 10-in.×6½-in.

(Longmans, Green and Co. Price 6/- net.)

Physiological Chemistry, it will be remembered, deals with the composition and properties of those carbon compounds which are constituents of living matter, and are concerned in vital processes. The Chemistry of the chief organic constituents of the human body and its secretions, and of the principal food-stuffs, are dealt with, from the practical standpoint, in the work before us. The present volume was, in fact, as we are reminded in the preface, originally compiled as a handbook for the practical work in Physiological Chemistry at University College, London. The text is conveniently arranged in paragraphs with headlines, while the descriptive matter is printed in large, and the practical work in smaller, type, and the author's name is a sufficient guarantee that every statement therein contained is in accordance with the most recent researches in this rapidly extending science.

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A good many excellent illustrations of the microscopic appearance of crystals of various organic substances are reproduced in the volume, and a coloured plate of the spectra of haemoglobin and allied compounds forms a useful frontispiece. A list of reägents of use in Physiological Chemistry, with the exact strength and mode of preparation of each, is given in the appendix, and there is also an excellent index. The volume is destined to become the standard class-book of Practical Physiological Chemistry.

PHYSIOLOGY.

Preliminary Physiology.—By WILLIAM NARRAMORE, F.L.S. 220 pages. 7½-in. × 5-in.
(Methuen & Co. Price 3/6.)

Nowadays every elementary teacher of every elementary subject regards it his duty or his privilege to bring out an elementary text-book in which to display his elementary knowledge of that subject. Such a book we have now before us. The elementary error that "at the moment of swallowing . . . . the epiglottis closes over the glottis," is repeated throughout its pages and even figured. Again, on Page 72 we read that, "Many of the white corpuscles contain more than one nucleus," the truth being that, while all the white corpuscles are uninucleate, most have a more or less branched nucleus, which might appear multiple to the casual observer. In the preface we read that, "The illustrations for the book have been prepared especially to help the teaching in the text." In this they succeed admirably, for many of them are equally inaccurate. The diagram of the nose on Page 172 gives one an entirely false idea of its bony structure, and the imaginative picture of the epiglottis neatly closing over the glottis, shown on Page 97, has already been referred to.

The one redeeming feature of the book is the series of micro-photos of animal tissues beautifully reproduced in the form of plates. Some of these, notably those representing the minute structure of skin, bone and muscle, are really excellent and worthy of a place among better surroundings. There are so many admirable text-books of elementary physiology, that we find it impossible to recommend the example now before us.

The Physiology of Reproduction.—By FRANCIS H. A. MARSHALL. 706 pages. 154 illustrations. 9-in. × 6-in.
(Longmans, Green & Co. Price 21/- net.)

This book is a carefully-written and most exhaustive treatise, dealing with the times at and periods during which various animals breed, and the changes that take place in the reproductive organs, including those of the female when pregnant. Comparisons are drawn between man and other animals, and the birth-rate is discussed. An interesting chapter deals with the factors that determine sex, and the book concludes with a consideration of the phases in the life of the individual.

Of Distinguished Animals.—By H. PERRY ROBINSON. 234 pages. 56 illustrations. 7¾-in. × 5¼-in.
(William Heinemann. Price, 6/- net.)

Portions of this most interesting volume appeared in the *Times* during 1909, under the title of "Studies in the Zoological Gardens." Those who enjoyed the articles then will welcome their publication in book form, more especially with the addition of the very excellent photographs taken in Regent's Park. All lovers of animals will read with great pleasure the racily-told anecdotes concerning the wild creatures, while the amount of information given anent them will cause future visits to the Zoo to be more enjoyable than ever.

Reptiles of the World.—By RAYMOND L. DITMARS. 373 pages. 89 plates. 9¼-in. × 6¼-in.
(Sir Isaac Pitman & Sons, Ltd. Price 20/- net.)

In this book, which is at once remarkable for the value and beauty of the illustrations, the classification of Dr. Boulenger has been generally adopted, and from it it is possible to get an excellent idea of recent reptiles. Various families are considered and tables are given of the genera, with the number of species known. Habits are touched upon and some details are included as to methods of feeding the animals. Besides the excellent pictures of the complete animals various parts are illustrated, such as the spurs of the Indian Python, which are the external portions of the well-formed hind legs possessed by members of the family Boidae. Another most striking illustration is of the head of the Pit Viper (a New World rattlesnake) showing the fangs.

The Airy Way,—By GEORGE A. B. DEWAR. 253 pages. 7¾-in. × 5-in.
(Chatto & Windus. Price 6/- net.)

This book is a series of essays, written in Mr. Dewar's well-known manner, which deal principally with flight; and such various creatures as butterflies, birds and bats are discussed because they are all endowed with wings. There is, however, much dealing with rural life and natural history, which goes to make an interesting volume.

NOTICES.

LESSONS IN NATURE STUDY.—A great deal of good might be done if schools would take advantage of the specimens of a seasonable character, accompanied by outline notes, which Mr. J. F. Rayner, of the Botanical Garden and Laboratory, Highfield, Southampton, is now sending out for the use of schools and teachers generally.

FORTHCOMING BOOKS.—Messrs. Baillière, Tindall and Cox announce that they are publishing immediately the following books:—"Atlas of First Aid," by B. Myers; "Military Sanitation," by E. B. Knox; "Micro-organisms," by M. Herzog.

The English translation of Professor Henri Bergson's most important work, *Creative Evolution*, will be published on March 3rd, by Messrs. Macmillan & Co. The book is arranged in four chapters, with the following headings: I. The Evolution of Life—Mechanism and Teleology. II. The Divergent Directions of the Evolution of Life—Torpor, Intelligence, Instinct. III. On the meaning of Life—the Order of Nature and the Form of Intelligence. IV. The Cinematographical Mechanism of Thought and the Mechanistic Illusion—A Glance at the History of Systems—Real, Becoming, and False Evolutionism. The translator, Dr. Arthur Mitchell, refers to the help he received through the friendly interest and assistance of Professor William James, who, had he lived to see the completion of the English edition, had intended himself to introduce the work to English readers in a prefatory note. The author has himself carefully revised the whole work.

SPECTROSCOPIC APPARATUS.—We have received the revised and enlarged edition of Messrs. Adam Hilger and Co.'s general catalogue, in which there are illustrated and described a large series of spectrometers, spectrographs, polarimeters, and refractometers, together with the accessories that are required, and a list is given of the special sensitive plates manufactured for spectrographic work by Messrs. Wratten and Wainwright. A sectional list has also been issued by the same firm, dealing with Echelon diffraction gratings and Lummer-Gehrcke parallel plates.

A NEW TYPE OF PHOTOMETER.—Messrs. R. & J. Beck have brought out an instrument (The Holophane Lumeter) which they claim to be the first made for measuring the intensity of light as seen by the eye and not emitted from a light source. It is a small portable instrument, containing an illuminated disc with an aperture in the centre through which the object to be examined is looked at. The illumination of the disc is then adjusted until it is the same as that of the object to be tested when the brightness of the latter can be immediately read off on a scale of candle-feet. There are many uses to which such a photometer may be put—for instance, it can be used to ascertain whether the light on a book is sufficient to read by without straining the eyes.

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